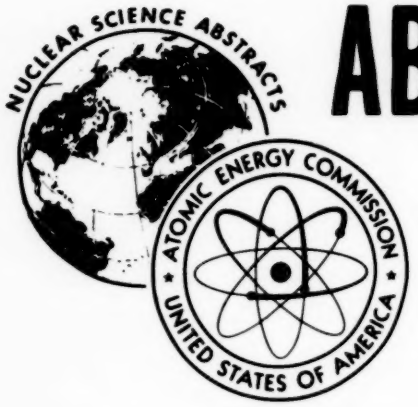
NUCLEAR SCIENCE ABSTRACTS



Volume 25 Number 16

Abstracts 37259-39403

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August 31, 1971

UNITED STATES ATOMIC ENERGY COMMISSION
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Volume 25, Number 16, August 31, 1971

NUCLEAR SCIENCE ABSTRACTS

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

ISHIHARA, T., Accumulation of fallout ^{137}Cs in newborn infants, 23:50538
ISHIHARA, Toyokuki, Shielding effect of paraffin, water, soil, concrete, Fe, and Pb for high-energy neutrons, 23:51748

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

MELPHALAN
  effects on proliferation of cultured antigen-stimulated spleen cells from mice, dose-response curve for, 23:50620
MEMBRANE FILTERS
  design for removal of cell-free Streptococcus faecalus from bacteria cultures in fermentation tank, 23:49996 (UCRL-18667, pp 322-9)
MENDELEVIUM
  separation from einsteinium and fermium by electrolysis, 23:49772 (UCRL-18667, pp 277-312)
  separation from sodium acetate solutions by solvent extraction using sodium amalgam, 23:49772 (UCRL-18667, pp 277-312)
  stability of divalent state of, 23:49772 (UCRL-18667, pp 277-312)

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

51093 (LA-4164) FABRICATION OF BORON CARBIDE RINGS AND DISKS. Sheinberg, H.; Herrera, T.; Kostacopoulos, J. **(Los Alamos Scientific Lab., N. Mex.).** Apr. 25, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

is indexed as:

LOS ALAMOS SCIENTIFIC LAB., N. MEX.
  Fabrication of boron carbide rings and disks, 23:51093 (LA-4164)

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Volume 25, Number 16 August 31, 1971

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 37403 and 37514.

37259 (BNWL-1551(Pt.2), pp 51-62) RADIATION INSTRUMENTATION: RADIOLOGICAL CHEMISTRY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

The development of radiochemical instrumentation and analytical technology, their utilization in radioisotope studies of environmental samples, their application to neutron activation analysis to define stable element versus radioelement behavior, and their use in the elucidation of the routes described by natural, tracer, or waste radioisotopes in the environs are discussed. (auth)

37260 (UCRL-50006-71) 1970 ANALYTICAL CHEMISTRY ANNUAL REPORT. Harrar, J. E. (comp.) (California Univ., Livermore. Lawrence Radiation Lab.). 5 Mar 1971. Contract W-7405-eng-48. 69p. Dep. NTIS.

Projects and techniques described include developments in computer automation of mass spectrometry, vacuum fusion analysis, combustion carbon analysis, atomic absorption spectrophotometry, and interactive data processing; analyses by high- and low-resolution mass spectrometry and gas chromatography; gas analyses at the Nevada Test Site; studies in emission, microwave, NMR, x-ray fluorescence, luminescence, infrared, Auger, ionization, proton backscattering, atomic absorption, and electron microprobe spectroscopy; gel permeation chromatography; development of new apparatus for atomic absorption work, NMR, and gas chromatography; new wet chemical methods for inorganic, organic, and explosive materials; ion-selective electrode titrations; determinations of low-level deuterium in water, hydrogen, and biological materials; controlled-potential coulometry; a study of the determination of moisture in rock materials by microwave absorption; a study of the sampling of rock during the drilling of device emplacement holes; studies of the thermal behavior of calcite and dolomite; NMR measurements of zinc and cobalt complexation by organic and biological molecules; new emission spectral data for berkelium, californium, and einsteinium; the development of a communications link between minicomputers and the Computations Center; and the measurement of rates of permeation of gases through plastics. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 37426, 37769, 37796, and 37840.

37261 (BARC-521) DC ARC METHOD FOR THE DETERMINATION OF RARE EARTH IMPURITIES IN YTTRIUM OXIDE. Grampurohit, S. V.; Naik, R. C.; Sindgikar, Kum S. B. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 9p. Dep. NTIS (U. S. Sales Only).

A dc arc method was worked out for the estimation of the impurities Gd, Tb, Dy, Ho, and Er in yttrium oxide. Yttrium oxide is mixed with graphite in the ratio 1:1 and 10 mg of this mixture is used as charge in a dc arc running at 8 amps. The spectra are recorded on a grating spectrograph with a 30,000 lines/inch grating blazed at 3300 Å in the first order at a linear dispersion of 2.5 Å/mm. Working curves are obtained with synthetic standards. A weak yttrium line is chosen as an internal standard. The method achieves a sensitivity ranging from 20 to 50 ppM and the average standard deviation for different elements varies from 10 to 20% (auth)

37262 (BARC-532) SPECTROGRAPHIC ANALYSIS OF HIGH PURITY EUROPIUM OXIDE. Murty, P. Sreerama; Khanna, P. P. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 9p. Dep. NTIS (U. S. Sales Only).

A dc arc spectrographic method is described to estimate Sm, Gd, and Tb in high-purity europium oxide. The sample, after being ground in the ratio 1:1 by weight with spec-pure conducting graphite powder (U.C.C. 200 mesh), is taken in a $\frac{1}{16}$-in.-dia graphite electrode and arced against a $\frac{3}{16}$-in.-dia graphite electrode. The spectra are photographed on a plane grating spectrograph using a 30,000 l.p.i grating in the second order in the region 3250 to 3850 Å. The concentration ranges covered are: 0.005 to 0.1% for Sm and Gd; 0.01 to 0.1% for Tb. The precision of the method is ±16%. (auth)

37263 (BARC-533) SPECTROGRAPHIC DETERMINATION OF LEAD AND TELLURIUM IN Bi-Pb AND Bi-Te ALLOYS. Murty, P. Sreerama; Khanna, P. P. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 9p. Dep. NTIS (U. S. Sales Only).

A spectrographic method is described for estimation of lead and tellurium in their alloys with bismuth in the concentration range of 0.002 to 0.1% for lead and 0.02 to 0.5% for tellurium. The sample is ground with spec-pure conducting graphite powder in the ratio 1:1 by weight and 15 mg of the mixture is arced in a dc and the spectra are photographed in the region 2300 to 3050 Å. Pb 2614.2 Å and Te 2385.8 Å are chosen as analytical lines while Bi 2582.2 Å and Bi 2448.1 Å, respectively, served as internal standard lines. The precision of the method is about ±10%. (auth)

37264 (BARC-536) SPECTROGRAPHIC ANALYSIS OF HIGH PURITY Dy_2O_3, FOR TRACE AMOUNTS OF Er, Gd, Ho, Tb, AND Y. Ghodgaonkar, G. S.; Khanna, P. P.; Venugopalan, A. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 12p. Dep. NTIS (U. S. Sales Only).

A spectrographic method is described for analysis of high-purity Dy_2O_3 for trace amounts of Er, Gd, Ho, Tb, and Y. The Dy_2O_3 sample is mixed with an equal quantity of spec-pure graphite, 15 mg of the mixture are excited at 8 amp, and the spectra are photographed on a 3.4-meter grating spectrograph, using a 30,000 lines/inch grating, in the region 3175 to 4425 Å in 1-order. The concentration ranges covered for different impurity elements are: Er, 0.005 to 0.5%; Gd, 0.01 to 1.0%; Ho, 0.01 to 0.5%; Tb, 0.02 to 1.0%; and Y, 0.01 to 1.0% with a mean standard deviation of ±10%. (auth)

37265 (BARC-540) AC SPARK METHOD FOR THE DETERMINATION OF YTTRIUM IN RARE EARTH MIXTURES. Grampurohit, S. V.; Sethumadhavan, A. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 13p. Dep. NTIS (U. S. Sales Only).

A spectrographic method is described for the determination of yttrium in rare earth mixtures. The sample is mixed with pure ceria and zinc oxide in the ratio 2:1:2 and 5 mgm of this mixture are fixed on the top of flat-top electrodes. The spectra are excited using a spark source and recorded on a large quartz spectrograph in the region 2350 to 3300 Å. The concentration range covered is 1 to 90% and the mean percentage standard deviation is about 3.5%. (auth)

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37266 (CEA-R-4111) SPECTROPHOTOMETRIC METHOD OF MEASURING PLUTONIUM CONCENTRATIONS IN THE ORGANIC PHASE. Brutus, Andre (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Mar 1971. 79p. (In French). Dep. NTIS (U. S. Sales Only).

A method of measuring plutonium concentrations in the organic phase of the Purex process is presented, the minimum concentrations detectable being of the order of 10^{-5}M. Spectrophotometric measurements were made at 665 nm on plutonium complexes with Arsenazo III in the organic phase; several complexes can be formed between Arsenazo III and plutonium; the conditions under which a single complex can be obtained and those for which this complex obeys Beer's law were determined. The nature and stability of the complex formed were studied and the equilibrium constant and standard free enthalpy variation determined. The range in which this method can be applied was established from calculations of the regression line, confidence limits, detection limit and sensitivity. A method of eliminating certain troublesome cations from the medium was considered. (France)

37267 (IS-T-429) SPECTROSCOPIC PROPERTIES AND ANALYTICAL APPLICATIONS OF PREMIXED OXYGEN-HYDROGEN FLAMES. Mossholder, Nelson Vance (Ames Lab., Iowa). Jun 1971. Contract W-7405-eng-82. 104p. Dep. NTIS.

Thesis.

The emission and absorption of representative elements (Na, Ag, Zn, Cd, Pb, Mg, Cu, Be, Fe, Sr, Ca, Cr, Sn, Al, Ba, V, and Ti) were investigated in the premixed oxygen-hydrogen flame using experimentally determined response surfaces. The analytical utility of this flame was evaluated in terms of detection limits and solute vaporization interferences. The results of this study indicate that, in spite of its high maximum temperature (2950°K), the premixed oxygen-hydrogen flame offers few advantages as an atomization cell for flame spectroscopy. Powers of detection for the air-acetylene and oxygen-hydrogen flames are equivalent, but with few exceptions, detection limits determined in the oxygen-hydrogen flame are inferior, by factors of from 4 to 100, to those determined in the fuel-rich nitrous oxide-acetylene flame. In addition, serious solute vaporization interferences are observed in the oxygen-hydrogen flame, particularly in the cool, very fuel-rich flame required for maximal dissociation of even moderately stable metal monoxides. Degrees of metal monoxide formation, calculated for Na, Fe, Be, and Ti using a thermodynamic flame model, explain the experimental results and illustrate that even when solute vaporization is complete, elements that form very stable monoxides cannot be appreciably atomized in the premixed oxygen-hydrogen flame. (auth)

37268 (KFK-1360) DETERMINATION OF TRACES OF FLUORIDE, CHLORIDE, AND BORON IN PLUTONIUM-CONTAINING OXIDE FUELS. Mainka, E.; Coerdt, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Jan 1971. 24p. (In German). Dep. NTIS (U. S. Sales Only).

The determination of fluorine, chlorine, and boron in oxide fuels is described. These elements were separated from the matrix by pyrohydrolysis. This is a simple, rapid, and quantitative method. The determinations of fluoride and chloride are based on potential measurements of a fluoride- or chloride-sensitive electrode, versus a mercury sulfate electrode. A spectrophotometric method was used for determination of boron. (auth)

37269 (LA-tr-71-24) FEASIBILITY OF DESTRUCTIVE METHODS OF DETERMINING NUCLEAR FUEL IN VARIOUS MATERIALS. Markov, V. K. Translated by Helen Dahlby (Los Alamos Scientific Lab., N. Mex.), from Symposium on Methods of Application of Safeguards, Karlsruhe, July 6-10, 1970. 32p. (CONF-700701-7). Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 20911.

37270 (NP-18887) REPORT ON THE QUESTION OF THE MOST ADVANTAGEOUS EXCITATION VOLTAGE FOR X-RAY MICROANALYSIS. Hein, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). 10 Dec 1970. 37p. (In German). Dep. NTIS (U. S. Sales Only).

For x-ray microanalysis 3 to 4 times the critical excitation voltage is frequently applied as the most advantageous excitation voltage. In pure elements a favorable excitation voltage can be determined approximately from an equation, which was calculated according to measurements from a straight line on double logarithmic paper. Some elements in alloys and combinations show partly their maximum intensity in values of about 10 V_{Kr}. Other elements do not show a change in contrast to pure elements. For determination of the most advantageous excitation voltage impulse, measurements in relation to the excitation voltage must be carried out. If pure elements are to be used as comparison in quantitative measurements, the excitation voltages may not be put into areas in which the two curves in the impulse-excitation voltage diagram form a maximum but into that area where both curves take a linear course. (auth)

37271 KINETIC METHOD FOR THE QUANTITATIVE DETERMINATION OF RARE-EARTH ELEMENTS IN A MIXTURE. Yatsimirskii, K. B.; Budarin, L. I.; Khachatryan, A. G. (Inst. of Physical Chemistry, Kiev). Dokl. Akad. Nauk SSSR; 195: 898-9 (1 Dec 1970). (In Russian).

A method was developed for quantitative photometric analysis of rare earth elements present simultaneously in a mixture by using two or more parallel reactions that take place at different rates. The reaction involved is based on the interaction of colored complexes formed by the Xylene Orange (3,3-bis-di(carboxymethyl)aminomethyl-o-cresol sulfophthalein) and the rare earth ions with Trylon B. The formula derived was tested with a mixture containing $PrCl_3$ and $YbCl_3$ in the concentration range from 10:1 to 1:10. The reactions that had constants of 160 and 33 sec^{-1} were studied by the so-called "stop method." Calculation of the concentration on the basis of the calibration curve made with mixtures containing various known amounts of the components revealed that the method may be used for the determination of a rare earth element, the reaction rate constants of which differ from each other by a factor of at least four. (TTT)

37272 FURTHER DEVELOPMENT OF THE IODATE METHOD FOR THE IODINE AND ALKOXY GROUP DETERMINATION IN THE DECIMILLIGRAM RANGE. Pietrogrande, A.; Dalla Fini, G. (Univ., Padua). Mikrochim. Acta; No. 1, 14-20(1971). (In German).

A procedure is described that increases the sensitivity of the Leipert or Viebock and Brecher method for the determination of iodine and alkoxy. The liberated iodine is driven out into an alkaline solution by a stream of nitrogen and again oxidized to iodate, which permits a further liberation of iodine. Consequently, an initial iodine atom or an alkoxy group eventually corresponds to the liberation of 36 iodine equivalents. Thus it becomes possible to work with samples whose size is greatly reduced, whereas the consumption of thiosulfate is retained at a relatively high figure. (auth)

37273 TISSUE ALTERATIONS NEAR METALLIC HIP JOINTS: MICROANALYTICAL INVESTIGATIONS BY MEANS OF SPECTROPHOTOMETRY, ELECTRON MICROSCOPY, AND THE ELECTRON BEAM MICROPROBE. Semlitsch, M.; Willert, H. G. (Gebrueder Sulzer AG, Winterthur, Switzerland. Orthopaedische Univ. Balgrist, Zurich). Mikrochim. Acta; No. 1, 21-37(1971). (In German).

Abrasive inclusions of Fluorosint (mica-reinforced Teflon) and small amounts of metal were found by means of microanalytic investigations in the binding tissue near metallic hip joints having sockets made from Fluorosint. The experience gained from this investigation led to a series of improvements in the hip joint protheses with regard to design (fully rotational totalendoprostheses) and materials (improved chromium-cobalt based alloy-PROTASUL as well as hard, tough, wear-resistant plastic material in frictional contact with the metal). (auth)

37274 EXTRACTION OF BRILLIANT GREEN FLUOROTANTALATE BY CHLOROFORM. GRAVIMETRIC DETERMINATION OF TANTALUM. Nevzorov, A. N.; Onoprienko, N. S.; Mordvinova, S. N. Ind. Lab. (USSR) (Engl. Transl.); 36: No. 10, 1491-3(Oct 1970).

Translated from Zavod. Lab.; 36: No. 10, 1176-8(Oct 1970).

The extraction of brilliant green fluorotantalate by chloroform was investigated and a method developed for determination of tantalum when present in amounts of 10% or more. Optimum conditions were chosen and 99.6 to 99.95% of the tantalum passed into the organic phase after one extraction. The extraction-gravimetric method was tested on four different concentrates. (M.C.G.)

37275 LUMINESCENCE DETERMINATION OF PRASEODYMIUM IN HIGH-PURITY LANTHANUM OXIDE. Smirdova, N. I.; Efryushina, N. P. (Inst. of General and Inorganic Chemistry, Odessa). Ind. Lab. (USSR) (Engl. Transl.); 36: No. 10, 1501-3 (Oct 1970).

Translated from Zavod. Lab.; 36: No. 10, 1183-5(Oct 1970).

The possibility of using the luminescence of phosphor crystals based on lanthanum oxychloride activated with praseodymium, under excitation by uv light, for determination of praseodymium in lanthanum oxide was investigated. The sensitivity of the method amounted to 5×10^{-6}% Pr^{3+} at 502 nm and 3×10^{-5}% at 66 nm. The standard deviation did not exceed 5.5%. (M.C.G.)

37276 THORIUM MICRODETERMINATION. Archimbaud, Michelle; Noel, Alban (CEA, Pierrelatte, France). Chim. Anal. (Paris); 53: No. 3, 161-4(Mar 1971). (In French).

In a nitric acid medium, thorium forms anion complexes that allow isolation of this ion by means of anion resins. Spectrophotometric measurement is then carried out on a wavelength of 660 mμ, by forming a complex with Arsenazo III. The determination limit is equivalent to a thorium concentration of about 0.7 μg in the sample. (auth) (France)

37277 COMPLEXOMETRIC DETERMINATION OF ERBIUM. Thakur, R. D.; Saxena, O. C. (Univ. of Allahabad, India). Chim. Anal. (Paris); 53: No. 3, 183-5(Mar 1971). (In French).

Erbium was determined quantitatively in microamounts by forming and decomposing the complex, erbium rhodizonate, with ceric sulfate. The complex between erbium nitrate and disodium rhodizonate was formed in the ratio of 1:3 and at pH 3.4. The maximum error in these experiments was 0.7%. A 0.0005N H_2SO_4 solution has an affect on the complex. Interference by metal ions is also observed. (auth) (France)

37278 SPECTRAL DETERMINATION OF IMPURITIES IN MOLYBDATES OF SODIUM AND THE RARE EARTH ELEMENTS (EXCHANGE OF EXPERIENCE). Raginskaya, L. K.; Manova, T. G.; Sotnikova, V. N. Ind. Lab. (USSR) (Engl. Transl.); 36: No. 11, 1716-17(Nov 1970).

Translated from Zavod. Lab.; 36: No. 11, 1348(Nov 1970).

Gallium oxide and sodium iodide were added to molybdate samples in order to suppress interferences from sodium and the rare earths. Fe, Cu, Sn, Cr, Ni, Mn, Mg, Al, V, Ca, and Si were determined. Sensitivity was 1×10^{-4} to 1×10^{-3}%; reproducibility was 10 to 20%. (J.G.B.)

37279 APPLICATION OF THE DEPENDENCE OF LINE INTENSITY ON THE ACCELERATING VOLTAGE FOR DETERMINING THE CONCENTRATION IN X-RAY MICROANALYSIS. Kurpiyanova, T. A.; Ditsman, S. A. Ind. Lab. (USSR) (Engl. Transl.); 36: No. 11, 1705-7(Nov 1970).

Translated from Zavod. Lab.; 36: No. 11, 1340-2(Nov 1970).

A method was developed by which the concentration of an element is determined by measuring the ratio of the intensities of the analyzable line in the sample and standard and the ratio of the currents passing through the sample and the standard at various accelerating voltages and plotting the dependence of intensity ratios on the accelerating voltage. Experimental results from various authors were used for calculating concentration of elements in several systems, including U–C, U–N, U–P, U–S, U–Fe, U–Si, and U–Ni. (J.G.B.)

37280 SPECTRAL DETERMINATION OF OXYGEN IN NIOBIUM. Egorov, V. N.; Gryzlov, Yu. N. Ind. Lab. (USSR) (Engl. Transl.); 36: No. 11, 1708-11(Nov 1970).

Translated from Zavod. Lab.; 36: No. 11, 1342-5(Nov 1970).

An attempt was made to improve the Fassel method for determining oxygen in refractory metals. Changes in the design of the vacuum chamber led to more accurate results. At an O content in Nb of 7×10^{-3}%, the coefficient of variation of the method is 12%. (J.G.B.)

37281 X-RAY SPECTROSCOPIC DETERMINATION OF NIOBIUM IN SOLUTIONS BY THE INTERNAL STANDARD METHOD. Smagunova, A. N.; Pavlinskii, G. V.; Andreeva, L. Ya.; Losev, N. F. (Irkutsk State Scientific-Research Inst. of Rare and Nonferrous Metals, USSR). Ind. Lab. (USSR) (Engl. Transl.); 36: No. 11, 1700-4(Nov 1970).

Translated from Zavod. Lab.; 36: No. 11, 1336-40(Nov 1970).

A method was developed for the determination of Nb in evaporated residues of solutions by x-ray spectroscopy using Mo as the internal standard. Coefficient of variation of reproducibility of analysis was 4.9%. Limits of detection of Nb in solution depended on the weight of the residue, varying from 0.5 to 30 mg/l. (J.G.B.)

37282 THIN-LAYER CHROMATOGRAPHIC DETECTION OF IODIDE IMPURITIES IN AROMATIC AMINO ACIDS ON TWO-LAYER PLATES. Gartzke, J. (Medizinisch-Diagnostisches Institut, Berlin). J. Chromatogr.; 57: No. 1, 163-4(22 Apr 1971). (In German).

37283 FLUORIMETRIC DETERMINATION OF ZIRCONIUM AS 8-HYDROXYQUINOLINATE IN THE PRESENCE OF TITANIUM, TUNGSTEN, AND MOLYBDENUM. Schneider, H. O.; Roselli, M. E. (Univ. Nacional, La Plata). Analyst; 96: No. 1142, 330-4(May 1971).

A fluorimetric method is described for the determination of small amounts of zirconium as 8-hydroxyquinolinate. The procedure, which involves extraction of the chelate with chloroform from a hydrofluoric acid–ammonium tartrate solution at pH 9.0, permits the determination of zirconium in the presence of titanium, tungsten, and molybdenum. Excitation is conducted at 398 nm and emission measured at 520 nm. Down to 0.1 μg of zirconium can be determined with a coefficient of variation of 2.3%. (auth) (UK)

37284 ISOTOPIC ANALYSIS OF URANIUM BY AN OPTICAL SPECTRAL METHOD. IV. STUDY OF THE SUITABILITY OF SOME URANIUM LINES FOR THE ABSOLUTE DETERMINATION OF ISOTOPIC RATIOS. Rossi, G. (CCR–EURATOM, Ispra, Italy). Spectrochim. Acta, Part B; 26: No. 5, 271-8(May 1971).

The possibility of using U lines other than the 4244 Å line for an optical spectral determination of $^{235}U/^{238}U$ isotope ratios was investigated. The isotopic pattern of the lines at 4116.097, 4689.074, and 4859.750 Å was studied. The structure at 4116 Å was found to be the most attractive owing to the very low hyperfine structure effect on the ^{235}U component. Absolute isotope ratio measurements were obtained for ^{235}U concentrations between 10 and 93%, the relative sample-to-sample variance being 0.5% at the lowest concentration level. Below 10% of ^{235}U a moderately intense line interferes at the position of the ^{235}U line, thus limiting at present the applicability of the described method. The possible nature of the interference line is discussed. Some preliminary results on the absolute determination of $^{236}U/^{238}U$ isotope ratios, obtained on the structure at 4244 Å, are also presented. (auth) (UK)

37285 DETERMINATION OF CHROMIUM AND MOLYBDENUM IN A COMPLETE RANGE OF STEELS BY ATOMIC-ABSORPTION SPECTROMETRY WITH A NITROUS OXIDE–ACETYLENE FLAME. Thomerson, D. R.; Price, W. J. (Pye Unicam Ltd., Cambridge, Eng.). Analyst; 96: No. 1142, 321-9 (May 1971).

Interferences in the absorbance of chromium and molybdenum in steels are overcome in the nitrous oxide–acetylene flame by using perchloric acid as the solvent. The method is rapid and suitable for any level of chromium or molybdenum found in steels and other metallic alloys. An alternative method for the determination of molybdenum is necessary, however, when the tungsten concentration exceeds 0.5 percent; this involves the use of a perchloric–phosphoric–sulphuric acid mixture to retain the tungsten in solution. A difference read-out technique to obtain good precision for high levels of chromium is described. (auth) (UK)

37286 IMPROVEMENTS TO CALORIMETRIC METHODS FOR DETERMINING RADIOACTIVE GASES. Mercier, Jacques (to Societe d'Etudes d'Automatisation de Regulation et d'Appareils de Mesure). French Patent 2,031,772. 9 Nov 1970. Filed 7 Feb 1969. (In French).

A procedure for measuring a radioactive product in a gas or mixture of gases is described. A sealed calorimetric enclosure with a means of continuously measuring the heat released is used. The enclosure is evacuated and left to reach thermodynamic equilibrium. A quantity of the gas to be measured is allowed to enter the enclosure, the temperature being known. The quantity of heat produced by the thermodynamic transformation resulting from the introduction of the gas is measured. The system is left until a permanent thermodynamic region is attained and the calorific power produced by the radioactive product under these physically stable conditions is measured. The ratio of the two previously measured quantities is considered. This ratio, when multiplied by a calibration coefficient gives the contents of the radioactive product contained. This process applies to real gases and to gases similar to perfect gases. (France)

37287 AMPEROMETRIC TITRATION OF SUBMILLINORMAL CONCENTRATIONS OF CERIUM(IV) WITH MERCURY(I) PERCHLORATE. Merrer, R. J.; Stock, J. T. (Univ. of Connecticut, Storrs). Analyst; 96: No. 1142, 361-3(May 1971).

The amperometric titration with mercury(I) perchlorate of 1×10^{-4} N cerium(IV) in 0.01 N potassium iodide–0.2 N perchloric acid solution is described, and found to be precise and accurate to within about 2%. (auth) (UK)

37288 ANALYTICAL UTILIZABILITY OF NITRITE TRIPLE SALTS. Hetzel, Helmut F. Mikrochim. Acta; No. 1, 54-6 (1971). (In German).

Strontium forms a difficultly soluble triple salt of the composition $K_2SrNi(NO_2)_6$, which can be used for detection purposes in qualitative analysis. When the strontium solution is mixed with a nickel salt and potassium nitrite in the presence of an acetate buffer, light brown strongly refractive cubes appear at once. Barium gives an analogous reaction, but not calcium. Calcium interferes if present in large excess. (auth)

37289 PHLOREIN AS A NEW COMPLEXOMETRIC INDICATOR FOR THE DETERMINATION OF Bi^{3+} IONS. Lasovsky, J.; Ruzicka, E. (Palacky Univ., Olomouc, Czech.). Mikrochim. Acta; No. 1, 57-62(1971). (In German).

The reaction of Bi^{3+} with phlorein was studied spectrophotometrically. It was found that a 1:1 complex is formed in strong acid medium (0.1 M $HClO_4$). The probable stability constant log $\beta_{1,1} = 5.07$ was determined for this milieu. The complex formation can be used in a sensitive Bi^{3+}-determination. (auth)

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37290 ATOMIC ABSORPTION ANALYSES OF MINOR ELEMENTS IN SILICATE. Terashima, Shigeru (Geological Survey of Japan, Kawasaki). Jap. Anal.; 20: No. 3, 321-6(Mar 1971). (In Japanese).

A method was proposed for the rapid determination of cobalt, copper, lithium, nickel, lead, strontium, and zinc in various silicates by atomic absorption spectrophotometry. The sample was decomposed with a mixture of HF and $HClO_4$. After having been converted to the chlorides by HCl, the molecular absorption interference with determination of cobalt, nickel, lead, and zinc from aluminum, calcium, iron, etc., was eliminated by adding calcium to the standards. Strontium was determined by adding lanthanum to the samples and the standards. Copper and lithium were determined directly from the sample solution. The results on seven elements in nine silicate samples agreed well with those by other methods. A complete procedure required about 6 hr. (auth)

37291 MANUAL OF QUANTITATIVE ELECTRON PROBE MICROANALYSIS. Salter, W. J. M. London; Structural Publications (1970). 156p. Pound 5.25.

The subject is dealt with under the following headings: problems of quantitative microanalysis, the application of corrections, sources and values of data, computation of correction data, and computer programming and output. Data required to perform accurate analyses are contained in appendices. (UK)

37292 KHIMICHESKIE SVOISTVA I METODY ANALIZA TUGOPLAVKIKH SOEDINENII. (Chemical Properties and Methods of Analysis of Refractory Compounds). Frantsevich, I. N. (ed.). Kiev; Izdatel'stvo Naukova Dumka (1969). 164p.

This collection of 27 articles by various authors includes a discussion of some of the chemical properties of boron carbides, the phosphides of gallium, indium, and boron, the hydrides of some Group IV and V metals, and the sulfides and silicides of transition metals. Original methods of analysis of germanides of Ti, Zr, Hf, and Ta are described, as well as the determination of W in W–Mo alloys and of As in high-purity Mo. (K.S.W.)

37293 TITRIMETRIC DETERMINATION OF CERTAIN ELEMENTS WITH THE USE OF NONAQUEOUS SOLVENTS. Akimov, V. K.; Busev, A. I.; Emel'yanova, I. A.; Bragina, S. I.; Gel'fer, S. M. (Scientific-Research Inst. of Organic Intermediates and Dyes, Moscow. Moscow State Univ.). Zh. Anal. Khim.; 26: No. 5, 864-8(May 1971). (In Russian).

Titrimetric methods for determining iron, osmium, thallium, zinc, indium, cobalt, nickel, copper, bismuth, uranium, and thorium were developed. The methods are based on the precipitation of the elements with antipyrine and its derivatives, 8-hydroxyquinoline, sodium diethyldithiocarbamate, pyridine, or cupferron, and dissolving the precipitate in acetone or in a mixture of acetone with dimethyl formamide, followed by the titration with a solution of a base or an acid. (auth)

37294 CHROMATOGRAPHIC SEPARATION AND COMPLEXONOMETRIC DETERMINATION OF ALUMINIUM, TITANIUM, AND IRON IN THE MICROANALYSIS OF SILICATES. Kalinin, A. I.; Kalinina, N. E. (Inst. of Silicate Chemistry, Leningrad). Zh. Anal. Khim.; 26: No. 5, 881-5(May 1971). (In Russian).

A method for the microdetermination of Al, Ti, and Fe was developed. It is based on their chromatographic separation and complexonometric titration using gravimetric burets. It was found that Al, Ti, and Fe can be separated from Mg, Ca, Sr, Ba, Ni, Mn, Cu, Co, Zn, Pb, and rare earths. The proposed method permits the direct determination of aluminum after its chromatographic isolation. The results are reproducible within the limits of 0 to 0.3%. (auth)

37295 CHEMICAL-SPECTROGRAPHIC METHOD FOR THE DETERMINATION OF THE RARE EARTHS IN LANTHANUM AND ITS OXIDE. Slyusareva, R. L.; Kondrat'eva, L. I.; Peizulaev, Sh. I.; Nikolaeva, O. N. Zh. Anal. Khim.; 26: No. 5, 894-7(May 1971). (In Russian).

A chemical-spectrographic method for determining impurities of the rare earths in lanthanum was developed. The method is based on concentrating Sm, Eu, Gd, Dy, Ho, Er, Tm and Lu by their extraction with nondiluted tributyl phosphate from 15N HNO_3 followed by the spectrographic determination. The sensitivity of the method is $(2 \text{ to } 5) \cdot 10^{-4}$%, the mean variation coefficient is about 20%. (auth)

37296 EXTRACTION-FLUORIMETRIC STUDY OF THE MORIN–DIANTIPYRYLMETHANE COMPLEX OF LUTETIUM AND ITS DETERMINATION IN A MIXTURE WITH RARE EARTHS OF THE YTTRIUM SUBGROUP. Poluektov, N. S.; Lauer, R. S.; Gaidarzhi, O. F. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 26: No. 5, 898-903(May 1971). (In Russian).

Lutetium ions form a complex compound with morin and diantipyrylmethane in the presence of perchlorate ions which can be extracted with chloroform. Solutions of this compound exhibit a fluorescence on excitation with long wavelength ultraviolet light. The Lu : morin : diantipyrylmethane : perchlorate ion ratio in the complex is 1 : 1 : 2 : 1. A complex molecule is solvated with four chloroform molecules. The fluorescence reaction of the lutetium complex was used for its determination in a mixture with Yb, Tm, Er, and Ho oxides. The sensitivity of the method is 0.2% of Lu_2O_3. (auth)

37297 POSSIBILITY OF THE LUMINESCENCE DETERMINATION OF URANIUM WITH THENOYLTRIFLUOROACETONE. Dobrolyubskaya, T. S. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 26: No. 5, 926-9(May 1971). (In Russian).

The luminescence of the uranium complex with thenoyltrifluoroacetone at the temperature of liquid nitrogen was studied. The characteristic luminescence spectrum of uranium(VI) in a 0.003M thenoyltrifluoroacetone solution at 1×10^{-8} g/ml of U is shown. The main maximum of the luminescence spectrum is at ~522 nm. The luminescence can be used for determining uranium over a concentration range of 1×10^{-8} to 1×10^{-6} g/ml of U. Uranium is determined by the change of the band intensity at ~522 nm. (auth)

37298 INCREASING THE SENSITIVITY OF THE SPECTROGRAPHIC DETERMINATION OF THE PLATINUM METALS. Pavlenko, L. I.; Karyakin, A. V.; Simonova, L. B. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 26: No. 5, 934-8(May 1971). (In Russian).

Studies were made on factors affecting the feed of the platinum metals, their behavior in the zone of the direct current arc discharge, as well as the excitation conditions for use of their emission spectra for the quantitative analysis. The mean time within which the platinum metals are in the direct current arc is from 1.7×10^{-3} to 2.2×10^{-3} sec depending on their atomic weight. A study was made of the action mechanism of gallium oxide used as a carrier. A quantitative method was developed for determining platinum, palladium, ruthenium, rhodium, and iridium in carbon powder with a sensitivity of 10^{-4} to 10^{-3}% using the DFS-13 spectrograph. (auth)

37299 DETECTION AND QUANTITATIVE DETERMINATION OF SUBMICROAMOUNTS OF RUTHENIUM IN ZONES OF PAPER CHROMATOGRAMS AND ELECTROPHOREGRAMS BY A KINETIC METHOD. Varshal, G. M.; Koshcheeva, I. Ya.; Morozova, R. P.; Konopleva, O. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow. Ivanovo Chemical-Technological Inst., USSR). Zh. Anal. Khim.; 26: No. 5, 939-42(May 1971). (In Russian).

A catalytic method for developing chromatograms and electrophoregrams is suggested. The method permits increasing the sensitivity of the ruthenium zones determination at least an order as compared with known methods. Sensitivity of the ruthenium detection is 0.01μg in the zone. The quantitative elution of ruthenium(IV) from chromatogram zones followed by its determination by a kinetic method was studied. Sensitivity of the quantitative determination of ruthenium in the zone is 0.1 μg at the variation coefficient of not more than 10 to 11% (over the concentration range of 0.1 to 4 μg of ruthenium). The method suggested was used for studying submicroamounts of ruthenium in solutions by paper electrophoresis. (auth)

37300 INDIRECT PHOTOMETRIC DETERMINATION OF PHOSPHORUS USING THE COMPLEX FORMATION OF MOLYBDENUM WITH AZO DYES. Arslanova, N. V.; Myasoedova, A. S.; Sudakov, F. P. (Moscow State Univ.). Zh. Anal. Khim.; 26: No. 5, 947-52(May 1971). (In Russian).

Acid Chrome Violet K and Acid Chrome Black Special were used for the indirect determination of small amounts of phosphorus by complexing with molybdenum. Optimum conditions were found for the complex formation of molybdenum with the above-mentioned reagents and for the extraction and stripping of 12-molybdophosphate during its separation from the excess of molybdate. Methods for the indirect determination of phosphorus are proposed. The methods are based on the formation of 12-molybdophosphate in an aqueous solution, its extraction by a mixture of chloroform with butanol, its stripping with an alkaline solution followed by the photometric determination of molybdenum in the stripping solution by means of Acid Chrome Violet K and Acid Chrome Black Special. (auth)

37301 PHOTOMETRIC DETERMINATION OF FLUORINE IN U_3O_8 AND UO_2. Kukisheva, T. N.; Sinitsyna, E. S.; Efimova, N. S. Zh. Anal. Khim.; 26: No. 5, 953-5(May 1971). (In Russian).

A simple and rapid photometric method is suggested for determining small amounts of fluorine in uranium oxides without its

separation. The method is based on the weakening of the color intensity of the zirconium complex with Xylenol Orange in the presence of fluorine. The sensitivity of the method is 2.5×10^{-3}%. (auth)

37302 MASKING SUBSTANCES IN COMPLEXONOMETRY (A REVIEW). Yurist, I. M. (North-Western Correspondence Polytechnical Inst., Leningrad). Zh. Anal. Khim.; 26: No. 5, 975-91(May 1971). (In Russian).

A review of the literature (1950 to 1970) on inorganic and organic masking reagents is presented. Masking reagents for metals, including thorium and uranium, are given. (278 references) (J.G.B.)

37303 DEUTERIUM ORTHO-PARA ANALYSIS BY NUCLEAR SPIN-LATTICE RELAXATION MEASUREMENTS. Wang, Richard; White, David (Univ. of Pennsylvania, Philadelphia). Rev. Sci. Instrum.; 42: No. 6, 887-8(Jun 1971).

A new, more precise (±0.1 to 0.2%) method for ortho–para analysis in D_2 is described which is based on spin–lattice or longitudinal relaxation time, T_1, in liquid samples. The times T_1 are measured using the initial signal amplitude, $S(\tau)$, of the free induction decay. A plot of $1-S(\tau)/S(\infty)$ vs time shows that the Zeeman energy is transferred to the lattice via two processes T_1^o and T_1^p. Ortho–para analyses using this method and the macrothermal conductivity method are compared, and T_1^p and T_1^o values are tabulated. (D.L.C.)

37304 EQUILIBRATION METHOD FOR MEASURING LOW-OXYGEN ACTIVITIES IN LIQUID SODIUM. Smith, D. L. (Argonne National Lab., Ill.). Nucl. Technol.; 11: No. 1, 115-19 (May 1971).

An equilibration method was developed to measure accurately the activity of oxygen at low concentrations (<20 ppM) in liquid sodium. Vanadium wires were exposed to liquid sodium until the oxygen in solution in vanadium was in equilibrium with the active or free oxygen in sodium. The oxygen concentration in the vanadium detector was then measured by reliable techniques, and this value was related to the oxygen concentration in sodium by the equilibrium distribution coefficient. This method of analysis is specific for oxygen, and contamination problems associated with direct chemical analysis of low-oxygen sodium are eliminated. The accuracy of the method is ±15% in the range 0.1 to 15 ppM oxygen in sodium, and concentrations as low as 0.001 ppM are detectable. (auth)

Isotope Dilution Procedures

Refer also to abstract 37841.

Radiometric and Radiochemical Procedures

Refer also to abstracts 37584, 37623, 37626, 37802, 37803, 37814, 37820, and 39349.

37305 (A/CONF.49/P-842) DEVELOPMENT OF TECHNIQUES AND INSTRUMENTATION FOR NONDESTRUCTIVE ASSAY OF FISSIONABLE MATERIALS AND FIELD ASSAY EXPERIENCE. Keepin, G. R. (Los Alamos Scientific Lab., N. Mex.); Bramblett, R. L. (Gulf Radiation Technology, San Diego, Calif.); Higinbotham, W. A. (Brookhaven National Lab., Upton, N. Y.). Sep 1971. 19p. (CONF-710901-31). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Active and passive nondestructive methods for assay of fissionable materials are discussed. These include γ assay, passive neutron counting, neutron interrogation, bremsstrahlung interrogation, and methods using radioactive source for neutron interrogation. In-plant and field assay experience is described. Assay results are reported in three major categories associated with the nuclear fuel cycle: fuels, inventory samples, and fissionable material scrap and waste. The mobile nondestructive assay laboratories (MONAL and GAMAS) use neutron and photon interrogation sources as well as complementary passive assay equipment. (M.C.G.)

37306 (BNWL-1183-8) MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. Quarterly Research Report to the NASA Manned Spacecraft Center, January 4–April 4, 1971. Brodzinski, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Apr 1971. Contract AT(45-1)-1830. 41p. Dep. NTIS.

The concentrations of the radioisotopes observed in the feces from the Apollo 12 and 13 missions were normalized to the weight of the respective stable element in the specimens. The concentrations of 23 major, minor, and trace elements in the fecal samples from the Apollo 12 and 13 astronauts are reported. Body calcium and iron losses appear to be reduced during the Apollo 12 and 13 missions such that losses now seem to be insignificant. Refined measurements of tin excretion rates agree with normal dietary intakes. A passive dosimetry canister was designed, which contains foils of tantalum, copper, titanium, iron, cobalt, aluminum, and scandium. By measuring the concentrations of the various products of nuclear reactions in these metals after space exposure, the characteristics of the incident cosmic particles can be determined. A ^{210}Po concentration of $(2.58 \pm 0.41) \cdot 10^{-4}$ d/m/cm^2 was measured in a blank foil of the Solar Wind Composition experiment material exposed to the lunar atmosphere during the Apollo 12 landing. Analysis of the actual exposed foil is proceeding. A net increase in ^{210}Po activity, attributable to lunar exposure, can be correlated with the radon concentration of the lunar atmosphere. (auth)

37307 (BNWL-1551(Pt.2), pp 31-4) RADIOANALYTICAL PROCEDURE DEVELOPMENT. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

Radiochemical separation procedures, which are compatible with and augment advanced instrumental analysis technology, are required to provide a complete quantitative analysis of a radionuclide mixture. Methods described include: cosmogenic radionuclides in rainwater and Pu and Am in bone. (M.C.G.)

37308 (EUR-4612, pp 515-29) EXCREMENT ANALYSES WITH REGARD TO TRANSURANIUM ELEMENTS. Schieferdecker, H. (Kernforschungszentrum, Karlsruhe (West Germany)). (In German).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Experiments were carried out on a radiochemical treatment method for detecting transuranium elements in urine and feces based on DEHPA extraction. Depending on the aim of the analyses, this method can be applied either to a single transuranium element, or to Pu, Am, Cm, and CF simultaneously. The radionuclides are subsequently identified by alpha spectrometry in which activity amounts of 0.1 pCi can be determined. (auth)

37309 (INP-738) ANALYSIS OF SULPHUR COMPOUNDS BY MEANS OF GAS CHROMATOGRAPHY AND RADIOIONIZING DETECTORS. Lasa, J.; Korus, A.; Kilarska, M. (Institute of Nuclear Physics, Krakow (Poland)). 1970. 15p. (In Polish). Dep. NTIS (U. S. Sales Only).

The results of analysis of sulfur compounds using the gas chromatographic method and radioionization detectors are presented. It was ascertained that the argon-triode-type detector and electron-capture type detector allow the detection of 10 ppM of H_2S, 1 ppM of COS, 50 ppM of SO_2, and 0.02 ppM CS_2. (auth)

37310 MEASUREMENT OF SMALL AMOUNTS OF RADIUM AND RADON. Szy, D.; Urban, A. (Medizinische Semmelweis-Univ., Budapest. Hygienische Institutes der Hauptstadt, Budapest). Mikrochim. Acta; No. 1, 131-6(1971). (In German).

Various procedures employed for the measurement of slight ^{226}Ra and ^{222}Rn contents were also used for radiation hygiene. A cylindrical scintillation chamber of the most favorable dimensions offers the possibility of checking persons who have incorporated ^{226}Ra, without prior concentration of the breath-radon, and also in the analysis of foods and other samples that contain minute amounts of ^{226}Ra and ^{222}Rn. (auth)

37311 SYSTEM FOR ASSAYING SOLUTION CONTAINING ALPHA-EMITTING ISOTOPES USING TRACK-REGISTRATION MATERIAL. Alter, Henry Ward (to General Electric Co.). U. S. Patent 3,569,703. 9 Feb 1971. Filed 26 Feb 1968.

In a method for determining the quantity of α-emitting ingredient in a solution, a sheet of track-registration material is brought into close proximity to the solution, held there for a given period of time, and then removed. This material has the characteristic of forming damage tracks along paths traversed by α particles. These paths may be enlarged or made visible by treatment with a suitable etchant, which enlarges the tracks. The number of tracks formed in a given area is an indication of the quantity of the α-emitting ingredient present in the solution. (Offic. Gaz.)

37312 NEW METHOD OF COLLAGEN EXTRACTION FOR RADIOCARBON DATING. Longin, R. (Univ., Lyon). Nature (London); 230: 241-2(26 Mar 1971).

Frequent and often important errors in ^{14}C bone measurements occur arising chiefly because of the difficulty of completely eliminating pollutants during chemical treatment. A method is described that gives a good yield of pure collagen by extraction with slightly acid hot water after acid pretreatment of bones. The crushed bones are treated for a short period with 8% HCl, which results in

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breaking some of the H-bonds of the collagen, causing it to become soluble in hot water (pH = 3, 90°C). The extracted pure gelatin can be burnt, after over drying, to form the gas sample for counting purposes. The method also has the advantage of rapidity, simplicity, and use of simple chemical reagents. It can be used for partly burned bones, and probably for the extraction of the conchiolin of shells. The pure gelatin can also be dissolved in a suitable solvent and introduced directly into a liquid scintillation counter. Some comparative data are given. (UK)

37313 ANALYTICAL SENSITIVITIES AND ENERGIES OF THERMAL NEUTRON CAPTURE GAMMA RAYS. II. Senftle, F. E. (Geological Survey, Washington, D. C.); Moore, H. D.; Leep, D. B.; El-Kady, A.; Duffey, D. Nucl. Instrum. Methods; 93: No. 3, 425-59(1971).

A table of the analytical sensitivities of the principal lines in the thermal neutron capture gamma-ray spectrum from 0 to 3 MeV has been compiled for most of the elements. A tabulation of the full-energy, single-escape, and double-escape peaks has also been made according to energy. The tables are useful for spectral interpretation and calibration. (auth)

37314 MEASUREMENTS OF ^{89}Sr AND ^{90}Sr IN ENVIRONMENTAL SAMPLES BY LOW BACKGROUND β-RAY SPECTROMETER. Kamada, Hiroshi; Mita, Masae; Saiki, Masamichi (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo); 20: No. 5, 217-23(May 1971). (In Japanese).

The direct quantitative determination of ^{89}Sr and ^{90}Sr was successfully carried out by low background β spectrometry. According to this method, the ^{90}Y milking operation, which requires storage of $SrCO_3$ for 2 weeks after chemical separation from samples, could be omitted. Therefore, many samples could be analyzed in easier and shorter periods. An attempt to apply β spectrometry to the survey of the fallout-level of radioactivity was made. (auth)

37315 COMPUTER METHOD FOR ANALYSIS OF RADIOACTIVITY DATA FROM SINGLE- AND DOUBLE-LABELED EXPERIMENTS. Yund, Mary Alice; Yund, E. William; Kafatos, Fotis C. (Harvard Univ., Cambridge, Mass.). Biochem. Biophys. Res. Commun.; 43: No. 4, 717-22(21 May 1971).

A generally applicable program was devised for the machine processing and plotting of radioactivity data. The program can be used with single or double labeled experiments; it includes numerous options, which increase its flexibility and facilitate optimization of data presentation. (auth)

37316 ANALYSIS OF COMPOSITION OF COUNTERFEIT COIN APPLYING THE BACK SCATTERING OF BETA RAY. Kozuka, Hiroshi; Hoshi, Akiyoshi (National Research Inst. of Police Science, Tokyo). Kagaku Keisatsu Kenkyusho Hokoku; 23: No. 3, 243-6(Sep 1970). (In Japanese).

A counterfeit coin of 100 yen was analyzed using a ^{32}P source and a simple GM counter. Coin samples were made by pouring an alloy of tin and lead (solder composed of 9:1, 8:2, 7:3, 6:4, 5:5, 4:6, and 3:7 in weight ratio) into molds. A small source of ^{32}P in the form of Na_3PO_4 was sandwiched by two thin sheets of polyethylene and placed on a fixed location of coin sample just under a GM tube. The relation between counts and compositions of alloys was experimentally graphed. Backscattering counts of a legal coin were remarkably weaker than the solder alloy so the differentiation of legal and illegal coins was distinct. Conditions in analysis of coins by using backscattering of β particles are discussed. (auth) (Japan)

37317 MEASUREMENT OF THE CONTENT OF AN ELEMENT IN A SAMPLE BY γ-RAY ABSORPTION. Buffereau, Michel; Lavaud, Michel (to Commissariat a l'Energie Atomique) French Patent 2,029,181. 5 Oct 1970. Filed 15 Jan 1969. (In French).

A procedure for measuring the content of an element in a sample is described. The procedure consists of measuring the gamma intensities emitted by a source and their attenuation in the sample. Two sensibly monoenergetic radiations are used whose energies are just above and just below that corresponding to a discontinuity in the mass absorption coefficient of the element. The apparatus, which includes a gamma source emitting two different monoenergetic radiations, is described. Using ^{57}Co and ^{153}Gd, the quantity of U in solution was determined with a good reproducibility. (France)

Activation Procedures

Refer also to abstracts 37391, 37417, 37503, 37588, 37638, 37713, and 37746.

37318 (JUL-712-RE) BURNUP DETERMINATION THROUGH IRREVERSIBLE MIXING OF ACTIVATABLE ISOTOPES WITH FUEL. Muench, Erwin (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Forschungsreaktoren). Dec 1970. 101p. (In German). Dep. NTIS (U. S. Sales Only).

A nondestructive method for the determination of nuclear fuel burnup is described. To the fuel material an isotope is added that, after neutron activation, emits gamma radiation in the energy range between 1 and 1.4 MeV. Various suitable isotopes are discussed with respect to cross section and half-life. ^{59}Co was studied experimentally. The method permits burnup determinations as early as four days following the end of irradiation and within ten seconds. Possibilities for application as well as proposals for technical arrangement of the method are described. (H.B.G.)

37319 (RLO-1725-201) COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC: CHEMICAL AND GEOLOGICAL STUDIES. Progress Report, July 1970-May 1971. Carpenter, Roy (comp.) (Washington Univ., Seattle. Dept. of Oceanography). 21 May 1971. Contract AT(45-1)-1725. 19p. Dep. NTIS.

Research progress is reported on chemical, geochemical, and geological studies of the Columbia River effects in the Northeast Pacific, including the concentrations and behavior of mercury in the Columbia River water, suspended matter, and sediment; surveying the deep water and bottom sediment over the continental slope and borderland in an attempt to identify Columbia River sediment in the water column and accumulating on the bottom; and construction of a three-dimensional computer model of the Columbia River effluent. Two flameless atomic absorption techniques and a neutron activation technique were evaluated for the determination of mercury concentrations. (D.H.M.)

37320 (RT/CHI-(70)33) DETERMINATION OF MICRO AMOUNTS OF ELEMENTS CONTAINED IN NATURAL WATER BY MEANS OF NEUTRON-ACTIVATION ANALYSIS. Battiston, U.; Moauro, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 7 Oct 1970. 36p. (In Italian). (CONF-700717-1). Dep. NTIS (U. S. Sales Only).

From Conference on analytical and physical chemistry of water; Bormio, Italy (9 Jul 1970).

A systematic analytical procedure for determination of As, Au, Co, Cr, Hg, Re, Sb, U, and Zn in natural waters was developed employing neutron activation, gamma spectrometry, and exchange techniques. This procedure was then applied for the determination of microelements in the Tiber River between Corbaras dam and the mouth of the river (about 300 km). (auth)

37321 ACTIVATION ANALYSIS. Adams, F.; Op de Beeck, J. P.; Van den Winkel, P.; (and others) (Univ., Ghent). CRC Crit. Rev. Anal. Chem.; 1: No. 4, 455-586(Jan 1971).

Topics covered in this survey include: instrumental neutron activation analyses, computer applications, radiochemical separations, activation analysis with neutron generators, and photon and charged-particle activation analysis. (566 references) (M.C.G.)

37322 NEUTRONIC ACTIVATION METHOD FOR DETERMINING COBALT IN MAGNETIC CERAMIC MATERIALS. Gorshkov, V. V.; Mekhryusheva, L. I.; Smakhtin, L. A. Ind. Lab. (USSR) (Engl. Transl.); 36: No. 10, 1504-7(Oct 1970).

Translated from Zavod. Lab.; 36: No. 10, 1185-8(Oct 1970).

A neutron activation method was developed for determination of small amounts of Co in magnetic ceramic materials. Cobalt is separated by coprecipitating the diphenylquanidinium salt of the cobalt complex with 1-nitroso-2-naphthol-3,6-disulfonic acid together with inert organic coprecipitants 2,4-dinitroaniline and 2-naphthol. The samples are irradiated and then the cobalt is separated and counted. (M.C.G.)

37323 NEUTRON-ACTIVATION METHOD OF FAST DETERMINATION OF CARBON CONTENT. Tustanovskii, V. T.; Andryushchenko, V. I.; Volgemut, A. A.; Pronman, I. M. (State Research and Design Inst. of Rare Metal Industry, Moscow). Dokl. Akad. Nauk SSSR; 196: 570-2(Jan 1971). (In Russian).

A rapid neutron activation determination of carbon was carried out using a pulsed neutron generator with a neutron yield of 3×10^{10} n · sec^{-1} and a pulse duration 30 msec. A schematic design of the detector, specimen, and target is given. The recording system, the construction of the radiation transducer, and the amplitude discriminator were adjusted for the high ^{12}B radiation energy. Bismuth was used as construction and shielding material. The method permitted a rapid and accurate determination of carbon in steel and other solids without damaging the specimens. (R.V.J.)

37324 NEUTRON ACTIVATION DETERMINATION OF Cu, Zn, AND Mn IN ALUMINUM USING 8-MERCAPTOQUINOLINE. Veveris, O. E.; Michulis, Ya. D.; Riekstinya, D. V. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 1, 16-18(1971). (In Russian).

The neutron activation method for determination of micro impurities of Cu, Zn, and Mn in aluminum hydroxide was developed. Radiochemical separation by means of extraction with 8-mercaptoquinoline is used. The sensitivity of analysis is 3×10^{-9} g Cu, 2×10^{-7} g Zn, and 3×10^{-10} g Mn. (auth)

37325 ACTIVATION ANALYSIS AS A FAST METHOD FOR NON-DESTRUCTIVE DETERMINATION OF LANTHANUM IN PHOSPHATES. Daiev, Ch.; Apostolov, D.; Iovtchev, M.; Veltchev, Lj. (Univ., Sofia). Isotopenpraxis; 6: 460-2(Dec 1970). (In German).

Activation analysis was developed as a fast method for the nondestructive determination of lanthanum in phosphates. The method is based on ^{140}La activity measurement (τ 1/2 40 hours). The test and reference samples were irradiated in the IRT-1000 type reactor with a flux of 1.6×10^{12} n/cm^2/sec. At the same time, measurement was carried through by means of a 400-channel gamma spectrometer. Resolution of the Li-Ge detector was 0.2%, that of the NaI(Tl) crystal amounted to 7.6%. The standard deviation ranged from about 5% with a lanthanum content from 1 to 0.01% to 10 to 15% at lanthanum contents from 0.01 to 0.001%. The results correspond with those obtained by roentgen fluorescence analysis. (auth)

37326 NEUTRON ACTIVATION ANALYSIS OF COPPER CONCENTRATES. Fomenko, V. T.; Velyus, L. M.; Vasil'ev, S. S.; Fomenko, I. N. (Magnitogorsk Nosov Mining and Metallurgical Inst., USSR). Ind. Lab. (USSR) (Engl. Transl.); 36: No. 11, 1734-6(Nov 1970).

Translated from Zavod. Lab.; 36: No. 11, 1360-2(Nov 1970).

A method for determining Cu in Cu concentrates from various ore beneficiation mills was developed. Spectral equipment was not used. A Pu–Be neutron source was used to activate specimens with slow neutrons. A type RUP-1 radiometer was used for measurement of the neutron flux and γ-radiation level. Relative error was 1.7%. (J.G.B.)

37327 NEW METHOD OF ELEMENT ANALYSIS USING NUCLEAR RESONANCE SCATTERING OF GAMMA RAYS. Sowerby, B. D. (Australian Atomic Energy Commission, Sutherland). Nucl. Instrum. Methods; 94: No. 1, 45-51 (1971).

A new element analysis technique using nuclear resonance scattering of γ-rays is described. By irradiating a sample with γ-rays of energy very slightly greater than the energy of the nuclear level being excited and detecting the resonantly scattered radiation, a count rate proportional to the concentration of a specific element can be obtained. The main advantages of this technique over other nuclear methods of element analysis are simplicity and sensitivity to a specific element. Thirty-one stable isotopes are listed for which corresponding radioisotopes are available to initiate resonant γ-ray scattering. Successful experiments have been performed in simulated boreholes for the quantitative determination of copper and nickel using gaseous sources of ^{65}Zn I_2 and ^{60}Co Br_2 respectively. At present the sensitivity of the technique is limited by the intensity of the Compton scattered radiation. (auth)

37328 FAST NEUTRON ACTIVATION ANALYSIS OF TRACE LEVELS OF LEAD IN A NON-AQUEOUS FLOWING SYSTEM. Hayward, C. C.; Oldham, G.; Ware, A. R. (Loughborough Univ. of Tech., Eng.). Radiochem. Radioanal. Lett.; 6: No. 6, 381-8 (31 May 1971).

A system was developed for the fast neutron activation analysis of lead in nonaqueous solutions using the product isotope ^{207m}Pb ($T_{\frac{1}{2}}$ = 0.80 sec). The determination of lead down to trace levels is both feasible and reproducible. The method was successfully applied to a practical example, namely the determination of the lead content of petrol. (auth)

37329 RAPID AND NON-DESTRUCTIVE DETERMINATION OF PROTEIN IN GRAIN SAMPLES BY PROMPT (n, γ) TECHNIQUE. Tiwari, P. N. (Univ. of Uppsala). Radiochem. Radioanal. Lett.; 6: No. 6, 363-70(31 May 1971).

A rapid, nondestructive economical and reliable method for protein analysis in small grain samples and in single seeds was developed. The potentialities of the prompt (n, γ) technique to determine the quantity of protein without exposing the samples to significant radiation dose are examined. The parameters for the determination of the wheat grain protein are given. A reactor with high thermal neutron flux may be essential for the determination of the single seed protein. The bulk samples, however, may be analysed even by a small D–D neutron generator. (auth)

37330 TABLES OF GAMMA RAY ENERGIES FOR ACTIVATION ANALYSIS. Meixner, Christoph. Thiemig-Taschenbuecher, Band 38. Munich; Verlag Karl Thiemig KG (1970). 235p. DM 16,80. (In several languages).

In Table 1 the nuclides are arranged by atomic number and in Table 2 by ascending order of γ energies. In the third table the same nuclides are arranged in ascending order of half-life, and Table 4 contains a selection of the Table 1 nuclides and their γ energies below 100 keV. Table 5 contains the γ energies of nuclides suitable for calibrating spectrometers. (M.C.G.)

37331 DETERMINATION OF IRON, CHROMIUM, COBALT, NICKEL, AND SCANDIUM IN ASBESTOS BY NEUTRON ACTIVATION ANALYSIS. Holmes, A.; Morgan, A.; Sandalls, F. J. (Atomic Energy Research Establishment, Harwell, Eng.). Amer. Ind. Hyg. Ass. J.; 32: No. 5, 281-6(May 1971).

Iron, chromium, cobalt, nickel, and scandium were determined by neutron activation analysis (1) in the five UICC standard reference samples of asbestos, (2) in the individual samples of Canadian chrysotile, which were blended to produce the reference sample chrysotile B, and (3) in a number of samples of crocidolite from both the North West Cape and Transvaal deposits in South Africa. High resolution γ spectrometry was used to show that milling had not produced any significant change in the composition of the UICC standard reference samples. (auth)

37332 DETERMINATION OF EUROPIUM IN BIOLOGICAL MATERIALS BY NEUTRON ACTIVATION ANALYSIS. Ohno, Shigeru; Asprer, Gloria A.; Hongo, Shyozo; Suzuki, Masashi; Watanabe, Seiki (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo); 20: No. 5, 224-7(May 1971).

Europium in biological materials has been determined by neutron activation analysis. After dry or wet ashing, Eu was coprecipitated with oxalic acid as calcium oxalate, then the precipitate was collected on filter paper, and the irradiated sample was dissolved in 0.2 N HNO_3. The ^{152m}Eu was extracted with TBP and back-extracted with distilled H_2O. ^{152m}Eu was precipitated as europium hydroxide with ammonia water and collected on filter paper for the γ spectrometry. The precision of the method was calculated from the analysis of a standard specimen to be ~±6%, and the sensitivity of the method was estimated as 0.0001 ppM for this element. This method is also applicable to the determination of Eu used as an activable tracer. (auth)

37333 ACTIVATION ANALYSIS OF ^{197}Au FOR MEASURING RATE OF INGESTA PASSAGE IN RUMINANTS. Martz, F. A.; Asay, K. H.; Leddicotte, G. W.; Krause, G.; Daniels, L. B. (Univ. of Missouri, Columbia). J. Dairy Sci.; 54: No. 6, 926-8(Jun 1971).

Rate of ingesta passage was measured by a technique employing stable gold-resin complex and another technique using stained straw particles. Gold was determined by neutron activation. The gold-resin technique measured similar relative differences in rate of passage to the stained straw technique. (auth)

37334 JUSTICE. Int. At. Energy Agency Bull.; 13: No. 2. 29-32(1971).

The use of activation analysis to obtain proof in criminal cases is discussed. The sensitivity of the method makes possible analyses that could not be performed in other ways. (M.C.G.)

37335 ISOTOPE EXCITATION IN ON-STREAM ANALYSIS. Jenkins, R.; de Vries, J. L. (Philips' Research Labs., Eindhoven, Netherlands). Can. Spectrosc.; 16: 54-9(Mar 1971).

The potential usefulness of the radioisotope system in x-ray spectrometry for on-stream analysis was enhanced by the advent of the semiconductor counter, which offers significant improvement in energy dispersion over the more conventional detector systems. In addition to this, high energy output radioisotopes are now becoming available that allow the initiation of the neutron-activation process, this in turn offering great potential application in the on-stream analysis of the lower atomic number elements. The present state of the art in radioisotope excitation on-stream analysis is reviewed and its likely contribution in the future assessed. (auth) (Canada)

37336 STUDY OF PHOTON ACTIVATION ANALYSIS OF Dy AND Tm. PHOTON ACTIVATION ANALYSIS OF DYSPROSIUM AND THULIUM USING SAMARIUM AS AN INTERNAL STANDARD ELEMENT. Oka, Yoshinaga; Chuin, Pung-tong; Yokoi, Takeaki (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 1, 121-7(Oct 1970). (In Japanese).

Dysprosium and thulium were determined by measurement of the ^{157}Dy(photopeak 0.326 MeV) and ^{167}Tm(photopeak 0.208 MeV) that came from ^{158}Dy(γ,n)^{157}Dy and ^{169}Tm(γ,2n)^{167}Tm(γ,2n) ^{167}Tm reactions. As an internal standard nuclide, ^{151}Pm (photopeak 0.340 MeV) from ^{152}Sm, was used. When samarium, dysprosium, and thulium were irradiated with bremsstrahlung of maximum energy 30, 45, and 60 MeV, the following residual nuclides were observed, besides ^{151}Pm, ^{157}Dy, and ^{167}Tm: ^{143}Sm, ^{145}Pm, ^{148m}Pm, ^{143}Pm, ^{150}Pm, ^{147}Nd, ^{155}Dy, ^{155}Tb, ^{160}Tb, ^{161}Tb, ^{156}Tb, ^{169}Tm, ^{166}Tm, and ^{165}Tm. The mixtures of 25 mg of sa-

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marium with 14.47 mg to 67.0 μg of dysprosium or 1.90 mg to 8.8 μg of thulium were irradiated with bremsstrahlung of maximum energy 45 MeV for one hour and their radioactivity was measured after about ten hours cooling. Good linearity was found between the mixing ratio and the radioactivity ratio. The error was ±4.2% for dysprosium and ±3.8% for thulium. (Japan)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 37403 and 39019.

37337 CHEMISTRY OF ACTINIDE AND TRANSACTINIDE ELEMENTS. Cunningham, Burris B. (Univ. of California, Berkeley). pp 307-49 of Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research. XIII. /Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970).

From Robert A. Welch Foundation conferences on chemical research. XIII. The transuranium elements; Houston, Tex. (17 Nov 1969). See CONF-691124.

Properties of elements are extrapolated for the 6d transition elements and for element 114. An attempt is also made to relate the properties of the actinide elements as they are known with their assigned position in the periodic table. Electronic configurations, ionization potentials, and ionic radii of elements 104 to 112 are discussed. (M.C.G.)

Chemical Properties

Refer also to abstracts 37292 and 39274.

37338 (ORO-1639-20) UNUSUAL OXIDATION STATES OF TRANSITIONAL ELEMENTS. Progress Report. Watt, George W. (Texas Univ., Austin. Dept. of Chemistry). 1 Jun 1971. Contract AT(40-1)-1639. 14p. Dep. NTIS.

37339 (UCRL-Trans-10533) REACTION SCHEMES OF A PREPARATION OF BERYLLIUM HYDRIDE. Mounier, Jean. Translated for Univ. of California Lawrence Radiation Lab., Livermore, from Compt. Rend., Ser. C; 265: 1261-3(1967). 5p. Dep. NTIS.

The thermal crackings of di-tert-butylberyllium and its etherate involve several reactions. In the first, there is a competition between the formation of BeH_2 and isobutene, and that of Be and isobutane. The yield of BeH_2, which is small, increases with temperature. In the second, the oxidation of BeH_2 by ether is superimposed on the previous reactions. It inhibits the decomposition of BeH_2, which results from the hydrogenation of the isobutene into isobutane, and the proportion of BeH_2 is considerably increased. (auth)

37340 IR SPECTROSCOPY STUDY OF URANYL DI-n-BUTYL PHOSPHATE. Teterin, E. G.; Shesterikov, N. N.; Krutikov, P. G.; Solovkin, A. S. Zh. Neorg. Khim.; 16: No. 3, 780-4(Mar 1971). (In Russian).

The compounds formed by the reaction of $UO_2(NO_3)_2$ with di-n-butyl phosphate in nitric acid solutions were investigated. The compounds possessed the following ratios: $U:NO_3:DBP = 1:0:2$, $1:1:4$, and $1:1:2$. Structures of these salts are proposed. (tr-auth)

37341 COMPLEX FORMATION BY NEPTUNIUM(IV) AND PLUTONIUM(IV) IN NITRATE SOLUTIONS. Moskvin, A. I. (Inst. of Physical Chemistry, Moscow). Zh. Neorg. Khim.; 16: No. 3, 759-64(Mar 1971). (In Russian).

Np(IV) complexing in nitrate solutions was investigated by means of TBP extraction, and the K_{eq} was found to be 1.33×10^2. The stability constants of the Np(IV) nitrate complex were computed with the M/addend ratio from 1 to 4, obtaining values of 6.8, 20.3, 35.4, and 35.1 for an ionic strength of 2.0. Stability constants were similarly calculated for Pu(IV) complexes with 1 and 2 nitrate groups. (tr-auth)

37342 COMPLEX COMPOUND FORMATION IN THE SYSTEM UO_2F_2-HF-H_2O. Tsvetkov, A. A.; Seleznev, V. P.; Sudarikov, B. N.; Gromov, B. V.; Peganov, V. A. (Moscow Chemical Technology Inst.). Zh. Neorg. Khim.; 16: No. 3, 768-71(Mar 1971). (In Russian).

Three compounds were discovered in the ternary system UO_2F_2-HF-H_2O: $H_2[UO_2F_4] \cdot 4H_2O$, $H[UO_2F_3] \cdot 2H_2O$, and $H[(UO_2)_2F_5] \cdot 4H_2O$. Additional characteristics of these salts were obtained by thermogravimetric and x-ray analysis. (tr-auth)

37343 COMPLEX FORMATION OF TETRAVALENT ACTINIDES WITH UREA IN NITRIC ACID SOLUTIONS. Shmidt, V. S.; Sokolov, V. S.; Kirillov, L. M. Zh. Neorg. Khim.; 16: No. 3, 785-8(Mar 1971). (In Russian).

The absorption spectra of nitric acid solutions of actinide(IV) nitrates that contained urea suggested the existence of complex compounds of the actinides with urea. Determination of the distribution coefficients of the actinide elements between 0.5 M HNO_3 and 0.73 M TBP in benzene aided in the confirmation of such complex formation by U(IV), Np(IV), and Pu(IV). The composition and stability constant of the Pu(IV) complex were determined in nitric acid solutions. (tr-auth)

37344 COMPLEX FORMATION OF URANIUM(IV) SULFATES WITH TRIBUTYLPHOSPHINE OXIDE (TBPO). Ellert, G. V.; Bolotova, G. T.; Krasovskaya, T. I. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 16: No. 3, 789-92(Mar 1971). (In Russian).

Neutral and acid complexes of U(IV) with TBPO are extracted from a sulfuric acid medium into a benzene solution of TBPO. Proposed compositions for the complexes are $U(SO_4)_2 \cdot 3$ TBPO (in neutral solution), and $(TBPO)_2 \cdot H_2U(SO_4)_3$ and TBPO $\cdot H_2U(SO_4)_3$ (both in acid solution). (tr-auth)

37345 HETEROPOLYTUNGSTATES WITH TWO HETERO-ATOMS (U^{4+} AND Th^{4+}). I. SYNTHESIS OF THE SODIUM SALTS, THE CORRESPONDING ACIDS, AND DETERMINATION OF THEIR BASICITY. Ripan, Raluca; Botar, A. (Inst. of Chemistry, Cluj). Rev. Roum. Chim.; 16: 235-8(Feb 1971). (In German).

A new group of heteropolytungstates with two hetero atoms with the general formula $Me^I_8[UTH\ W_{18}O_{61}] \cdot XH_2O$ was produced, where $Me^I = Na^+$, K^+, Rb^+, Cs^+, NH_4^+, Tl^+, etc. The sodium salt was analyzed both chemically and thermogravimetrically and its physical and chemical properties investigated. The acid, $H_8[UTh\ W_{18}O_{61}]$, was produced in aqueous solution and its basicity determined by conductometric titration with thallium(I) acetate. The value of the basicity was found to equal six, which was identical with that of the alkali metal salts. (tr-auth)

37346 HETEROPOLYTUNGSTATES WITH TWO HETERO-ATOMS (U^{4+} AND Th^{4+}). II. PHOTOCOLORIMETRIC INVESTIGATIONS OF THE FORMATION OF $[UThW_{18}O_{61}]^{6-}$ IN RELATION TO pH, TEMPERATURE, AND TIME. Botar, A.; Ripan, Raluca (Inst. of Chemistry, Cluj). Rev. Roum. Chim.; 16: 239-43 (Feb 1971). (In German).

Photocolorimetric investigations were made of the pH region and optimal yields of $[UTh\ W_{18}O_{61}]^{6-}$ in the reaction between sodium tungstate and U^{4+} and Th^{4+} ions in relation to pH, temperature, and time. The optimal yield was achieved by use of a sodium tungstate solution of pH 4 to 5. (tr-auth)

37347 CHEMICAL REACTION ENGINEERING. Proceedings of the Fourth European Symposium, Held in Brussels, 9-11 September 1968. Chem. Eng. Sci., Suppl.; 1-474(1971). (CONF-680987).

Thirty-eight papers were presented at this symposium in six sessions: transport phenomena in fluidized beds and slurry reactors, design principles of fixed bed catalytic reactors, transport phenomena in liquid phase and gas liquid reactors, chemical kinetics and reactor design, design of industrial processes, and reactor stability and control. Separate abstracts were prepared for two papers. (UK)

For abstracts of individual papers see: 37348 and 37405.

37348 KINETICS OF NON-CATALYTIC, NON-ISOTHERMAL, GAS-SOLID REACTIONS: HYDROFLUORINATION OF UO_2. Costa, Eduardo C.; Smith, J. M. (Univ. of California, Davis). Chem. Eng. Sci., Suppl.: 389-410(1971).

From fourth European symposium on chemical reaction engineering; Brussels, Belgium (9 Sep 1968). See CONF-680987.

A single pellet, stirred-tank reactor was used to measure temperatures, compositions, and rates of reaction for the hydrofluorination of $UO_{2.14}$ at atmospheric pressure. By correlating the rate with conditions at the reacting surface, the activation energy of the first-order reaction was found to be 6070 cal/g mole. Since the product forms an unreactive layer around the core of $UO_{2.14}$ and since the heat of reaction is high, significant concentration and temperature differences develop between the gas phase and the reaction surface. The temperature and rate data were used to calculate the effective diffusivity and thermal conductivity of the product layer under reaction conditions. An adaptation of a pseudo-steady state method was developed for predicting the conversion and temperature history of a pellet. Using rate constants for reaction and mass and energy transfer derived from the experimental data, this method gave good results. Predictions with estimated rate constants were poor, indicating that an accurate value was necessary for the effective diffusivity in the product layer. (auth) (UK)

37349 EFFECT OF ADMIXTURES ON THE REDUCTION OF β-URANIUM DIOXIDE BY HYDROGEN. Blasov, V. G.; Pis'menko, V. T. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Neorg. Khim.; 16: No. 5, 1396-1400(May 1971). (In Russian).

The density and lattice parameters were determined both for pure β-uranium dioxide and for admixtures with Y_2O_3, ThO_2, and Nb_2O_5. The effect of the concentrations of such additives on the physical constants indicated was observed. Consideration was given to the types of ionic and electron defects arising from the presence of the homophase additives, Y_2O_3, ThO_2, and Nb_2O_5, in the β-U_4O_9. The effect of these additives on the chemical reactivity of U_4O_9 during hydrogen reduction is discussed. (tr-auth)

37350 DI-n-BUTYL PHOSPHATES OF THORIUM AND IRON. Solovkin, A. S.; Krutikov, P. G.; Yakovlev, G. N. Zh. Neorg. Khim.; 16: No. 5, 1445-6(May 1971). (In Russian).

It was established that di-n-butyl phosphate (HA) formed water-insoluble compounds with Th and Fe at room temperature. When 0.2 M HNO_3 solutions of Th nitrate and HA were mixed, the precipitate could be dried at 40°C to a white, friable powder with the composition ThA_4. When 6 M HNO_3 was used, the product was a waxy, amorphous mass, composition $ThA_4 \cdot 2HA$. Neither material contained nitrate groups or water. The corresponding precipitate with Fe(III) has the constant composition FeA_3, being independent of the HNO_3 composition. (K.S.W.)

37351 URANOUS MOLYBDIC HETEROPOLYACID AND ITS AMMONIUM SALT. Baidala, P.; Smurova, V. S.; Torchenkova, E. A.; Spitsyn, V. I. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 197: 339-42(11 Mar 1971). (In Russian).

A method is given for preparation of a uranous molybdenum heteropolyacid. An analysis of properties of the new compound confirmed its similarity to the group of tetravalent thorium and cerium heteropoly complexes. The formula for the acid is $H_8(UMO_{12}O_{42}) \cdot 18H_2O$. The method of synthesis of the new heteropolycomplexes with ions of tetravalent metals as complexing agent is suggested for Pr, Pu, Np, and Am. (R.V.J.)

37352 FORMATION OF AN ADDITIVE COMPOUND IN A URANYL COMPLEX–TTA SYSTEM. Akiba, Kenichi; Suzuki, Nobuo (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 1, 144-5(Oct 1970). (In Japanese).

The solubility of uranyl thenoyltrifluoroacetonate (UO_2A_2) in organic solvents was measured in the presence of TTA (HA). The solubility of the uranyl complex increased with increasing TTA, which coexists in organic solvents. This is because undissociated TTA adds to the chelate UO_2A_2 and forms an additive compound ($UO_2A_2 \cdot nHA$). The solubility, S, of the uranyl complex is expressed as $S = S_0(1 + \Sigma K_n[HA]^n)$, where K_n is the formation constant for $UO_2A_2 \cdot nHA$. Analysis of experimental data according to this equation showed that only the 1 : 1 compound was formed in CCl_4, while not only the 1 : 1 compound but also the 1 : 2 compound was formed in n-hexane, n-heptane, and cyclohexane. The formation constant, K_n, was determined. Log K_1 and log K_2 were about unity and about two, respectively, for all the solvents. (Japan)

37353 PREPARATION OF URANIUM TETRAFLUORIDE BY HYDRAZINE REDUCTION OF URANIUM(VI) IN ALKALINE SOLUTION. Funaki, Koemon; Ishijima, Itaru; Sakuma, Hikoya (Tokyo Inst. of Tech.). Kogyo Kagaku Zasshi; 74: No. 3, 349-54(Mar 1971). (In Japanese).

The hydrazine reduction of uranium(VI) in alkaline solution and the preparation of uranium(IV) fluoride from the reduction product with aqueous hydrofluoric acid were examined. The addition of an excess amount of hydrazine hydrate to an ammonium uranyl oxalate solution at room temperature gave a quantitative yellow precipitate with a composition corresponding to $(N_2H_5)_2O \cdot 5UO_3 \cdot 8H_2O$. The reduction of uranium(VI) was not observed at room temperature. Similar results were obtained for the reaction of hydrazine hydrate with uranyl nitrate of uranyl chloride. The reduction of uranium(VI) to uranium(IV) occurred by boiling the yellow precipitate with mother liquor, forming a black hydrous uranium dioxide. The reduction rate of uranium(VI) increased with the increase of hydrazine concentration. For example, a reduction rate greater than 98% was obtained at a hydrazine concentration of about 5 moles/l for 2 hr boiling. Hydrous uranium tetrafluoride was formed by the action of aqueous hydrofluoric acid on the reduction product. The products obtained at about 90°C and at room temperature were $UF_4 \cdot \frac{3}{2}H_2O$ and $UF_4 \cdot \frac{5}{2}H_2O$, respectively. Anhydrous uranium tetrafluoride can be obtained easily by the usual method from the hydrous uranium tetrafluorides prepared by the process mentioned above. (auth)

Isotope Effects and Exchange

Refer also to abstract 37432.

37354 ISOTOPE EFFECTS IN CHEMICAL REACTIONS. Collins, Clair J.; Bowman, Newell S. (eds.). ACS Monograph. New York; Van Nostrand Reinhold Company (1970). 442p. $22.50.

Six chapters are included; an abstract was prepared for each. (J.G.B.)

For abstracts of individual chapters see: 37355–37360.

37355 KINETIC ISOTOPE EFFECTS: INTRODUCTION AND DISCUSSION OF THE THEORY. Van Hook, W. Alexander (Univ. of Tennessee, Knoxville). pp 1-89 of Isotope Effects in Chemical Reactions. /Collins, Clair, J. (ed.). New York; Van Nostrand Reinhold Co. (1970).

The following aspects of kinetic isotope effects are discussed: the transition state formalism, solution of the harmonic rate ratio equations, corrections to the harmonic rate ratio equations, two thoroughly studied systems (the hydrogen atom–hydrogen molecule reaction and the hydrogen molecule–chlorine atom reaction), and unimolecular reactions—nonequilibrium isotope effects. It is concluded that with few exceptions kinetic isotope effects can be rationalized in terms of the transition state model of chemical kinetics. The most important parameters determining the effects are the changes in force constants as the system is transferred from the reactant configuration to the transition state. For certain nonequilibrium systems other factors (such as quantum statistical weight effects) may be important. For certain cases corrections for tunneling, anharmonicity, effect of external motions, etc., might have to be considered. (157 references.) (J.G.B.)

37356 DEUTERIUM ISOTOPE EFFECTS IN SOLVOLYTIC SUBSTITUTION AT SATURATED CARBON. Shiner, V. J. Jr. (Indiana Univ., Bloomington). pp 90-159 of Isotope Effects in Chemical Reactions. /Collins, Clair, J. (ed.). New York; Van Nostrand Reinhold Co. (1970).

The use of secondary deuterium isotope effects for analysis of nucleophilic solvolytic substitution reactions is reviewed. Theoretical background, general mechanistic considerations, isotope effects on equilibria, α-deuterium effects and β-deuterium effects in solvolysis, and deuterium effects at remote positions are discussed. (128 references.) (J.G.B.)

37357 SECONDARY DEUTERIUM ISOTOPE EFFECTS AND NEIGHBORING GROUP PARTICIPATION. Sunko, Dionis E.; Borcic, Stanko (Inst. Rudjer Boskovic, Zagreb). pp 160-212 of Isotope Effects in Chemical Reactions. /Collins, Clair, J. (ed.). New York; Van Nostrand Reinhold Co. (1970).

The correlation between isotope effects observed in reactions which proceed by means of anchimeric assistance and the structure of the transition state is discussed. The main factor influencing the magnitude of α- and β-effects appears to be the degree of bridging in the rate-determining step. When γ-effects are observable, they can be rationalized on the basis of participation of the neighboring group. A consistently different pattern of β- and γ-effects has been observed in systems where neighboring group participation is excluded. Deuterium substitution is regarded as a very powerful tool for elucidating changes occurring in the rate-determining step of solvolytic reactions. (93 references.) (J.G.B.)

37358 ORIGIN AND INTERPRETATION OF ISOTOPE EFFECTS. Thornton, Elizabeth K.; Thornton, Edward R. (Pennsylvania Military Coll., Chester. Univ. of Pennsylvania, Philadelphia). pp 213-85 of Isotope Effects in Chemical Reactions. /Collins, Clair, J. (ed.). New York; Van Nostrand Reinhold Co. (1970).

Potential uses and limitations of interpreting isotope effects in terms of specific molecular properties and reaction mechanisms are reviewed. Examples are given of new techniques by which maximum information can be derived from isotope effect studies. Section titles include: isotope effects as nonelectronic substituent effects, nonisotopic concepts used in interpretation of kinetic isotope effects, and mechanistic studies involving the interpretation of kinetic isotope effects. (134 references.) (J.G.B.)

37359 ISOTOPE EFFECTS IN BIOLOGICAL SYSTEMS. Katz, Joseph J.; Crespi, Henry L. (Argonne National Lab., Ill.). pp 286-363 of Isotope Effects in Chemical Reactions. /Collins, Clair, J. (ed.). New York; Van Nostrand Reinhold Co. (1970).

A review is presented on deuterium isotope effects in living organisms, large-scale mass cultivation of fully deuterated algae, effects of deuterium on biopolymers, deuterium isotope effects on enzymes, effects of deuterium in multienzyme systems, and origins of deuterium isotope effects in living organisms. Brief mention is made of isotope effects of elements other than hydrogen that are important in living organisms and that have stable, heavy isotopes. (352 references.) (J.G.B.)

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37360 HEAVY ATOM ISOTOPE EFFECTS IN ORGANIC REACTION MECHANISM STUDIES. Fry, Arthur (Univ. of Arkansas, Fayetteville). pp 364-414 of Isotope Effects in Chemical Reactions. /Collins, Clair, J. (ed.). New York; Van Nostrand Reinhold Co. (1970).

A review is presented on heavy atom isotope effects in connection with decarboxylation and decarbonylation reactions, displacement reactions, elimination reactions, rearrangement reactions, reactions of carbonyl compounds, and miscellaneous reactions. (192 references.) (J.G.B.)

37361 EQUILIBRIUM ISOTOPE EFFECTS OF COMPLEX COMPOUNDS. Knyazev, D. A.; Ivlev, A. A.; Denisov, D. A.; Preobragenskaya, L. B. Isotopenpraxis; 6: 471-6(Dec 1970).

A simplified method for calculation of the partition function (β-factor) based on the application of the algebraic expressions for the isotopic increments of the FG-matrix spur of secular equations was developed. By means of this and the other methods, the β-factors of complex compounds with mono- and polyatomic ligands including chelates were calculated. The β-factors were found to be calculated according to the additive rule from β-factors of isostructural complexes with identical ligands. The probability of the appearance of different meanings of the separation factors for isotope exchange reactions of different classes was investigated. It was found that the equilibrium isotope effects of complex compounds are greatly dependent on the difference of valence states of the element, coordination numbers, and ligand type. (auth)

37362 ISOTOPE EFFECTS IN AUTO-OXIDATION. IX. COMPARISON OF THERMAL AND THERMO-OXIDATIVE STABILITY OF DEUTERATED AND NORMAL PVC. Trauzeddel, R.; Huebner, H.; Wetzel, K. (Zentralinstitut fuer Isotopen- und Strahlentechnik, Berlin). Isotopenpraxis; 6: 476-7(Dec 1970). (In German).

The thermo-oxidative stability of deuterated PVC in oxygen with added hydroquinone or dibenzoyl peroxide was compared with the gross isotope effect measured in pure nitrogen during the thermal degradation. (auth)

37363 MOLECULAR CONSTANTS OF SUBSTITUTED ETHYLENE-TYPE MOLECULES. I. CORIOLIS COUPLING CONSTANTS AND INERTIA DEFECTS OF VINYLIDENE HALIDES AND THEIR DEUTERATES. Jeyapandian, S.; Savari Raj, G. A. (Univ. of Madras). J. Mol. Struct.; 8: No. 1-2, 97-105(Apr 1971).

The inertia defects of some vinylidene halides and their deuterates were calculated on the basis of the general formulation developed by Oka and Morino. The initial sets of force constants, based on published data, were adjusted by a least squares procedure until they reproduced the fundamental vibrational frequencies to within ~1%. The Coriolis coupling constants (47 for each molecule) were evaluated by the method of Meal and Polo. The calculated inertia defects agree quite well with the observed values, which confirm the planarity of the molecules. (auth)

37364 MOLECULAR CONSTANTS OF SUBSTITUTED ETHYLENE-TYPE MOLECULES. II. CENTRIFUGAL DISTORTION CONSTANTS. Jeyapandian, S.; Savari Raj, G. A. (Univ. of Madras). J. Mol. Struct.; 8: No. 1-2, 107-14(Apr 1971).

The centrifugal distortion constants of some halogenated ethylene-like molecules (C_2X_4 and $H_2C=CX_2$) are calculated by evaluating all the seven independent $\tau_{\alpha\beta\gamma\delta}$'s for these planar asymmetric top molecules. The vibration-rotation coefficients, $\alpha^{\alpha\alpha}$, involved in the expression for $\tau_{\alpha\beta\gamma\delta}$ are conveniently expressed in terms of Wilson's δ vectors and L^{-1} matrices as $[a] = 2[L^{-1}][A]$ where [a] is a column matrix consisting of $\alpha^{\alpha\alpha}$ elements to be computed and [A] is another column matrix whose elements are computed using α_i^0, β_i^0, and γ_i^0 and Wilson's δ vectors. The evaluation of the a values becomes simple once the normal coordinate analysis for a molecule is completed. Moreover, one need not evaluate the $J^i_{\alpha\beta}$, the partial derivative of the $\alpha-\beta$ component of the inertia tensor with respect to the i^{th} symmetric coordinates, as required by the general method given by Kivelson and Wilson. (auth)

37365 LOW TEMPERATURE STUDY OF SELF-ASSOCIATED ALCOHOLS IN THE NEAR-INFRARED. Asselin, M.; Sandorfy, C. (Univ. of Montreal). J. Mol. Struct.; 8: No. 1-2, 145-58 (Apr 1971).

The fundamentals and first overtones of isopropanol, tert-butanol, and their deuterated analogs were measured at various temperatures down to −180°C in solvents that form rigid glasses at low temperatures. Linear relationships between temperature and the fundamental and first overtone frequencies were found, the slope being nearly the same for both. This equality is explained by the temperature variation of the anharmonicity constant which decreases with temperature. The change in anharmonicity is found to account for a large part of the frequency shift following hydrogen bond formation. A study of frequency changes due to isotopic substitution shows that the anharmonic behavior of isopropanol and tert-butanol can be interpreted with the three anharmonicity constants W, X, and Y. (auth)

37366 MOLECULAR VIBRATIONS AND MEAN AMPLITUDES OF CARBOXYLIC ACIDS. IV. FORMIC ACID DIMER. Alfheim, I.; Hagen, G.; Cyvin, S. J. (Technical Univ. of Norway, Trondheim). J. Mol. Struct.; 8: No. 1-2, 159-66(Apr 1971).

A normal coordinate analysis is performed for formic acid dimer. The developed harmonic force constants are used to calculate the mean amplitudes of vibration (u) for $(HCOOH)_2$, $(HCOOD)_2$, $(DCOOH)_2$ and $(DCOOD)_2$. The agreement with observed u values for some of the distances in $(HCOOH)_2$ is satisfactory. Calculated perpendicular amplitude correction coefficients for $(HCOOH)_2$ are also reported. (auth)

37367 MOLECULAR SYMMETRY AND CONFIGURATION OF ACETALDAZINE. STUDY OF VIBRATION AND VIBRATION-ROTATION SPECTRA. Tabacik, Vlado; Pellegrin, Valdo; Elguero, Jose; Jacquier, Robert; Marzin, Claude (Faculte des Sciences, Montpellier, France). J. Mol. Struct.; 8: No. 1-2, 173-93(Apr 1971). (In French).

The absorption and diffusion spectra of acetaldazine-d_0 (I) (pure liquid) were measured in the 150 to 4000 cm^{-1} region. The complementarity of the two spectra proves that the molecular symmetry is C_{2h}. Theoretical and experimental studies of the rotational envelopes of several parallel bands in the absorption spectra of I and its two deuteriated species [-d_6 (II) and -d_2 (III)] showed that the configuration is anti-anti. The synthesis of I, II, and III and the results of an NMR analysis are reported. The conclusions of previous works in this field are discussed. (auth)

37368 MICROWAVE SPECTRA OF ISOTOPIC BENZONITRILES. REFINED MOLECULAR STRUCTURE OF BENZONITRILE. Casado, Julio; Nygaard, Lise; Soerensen, G. Ole (Univ. of Copenhagen). J. Mol. Struct.; 8: No. 1-2, 211-24(Apr 1971).

The microwave spectra of benzonitrile and nine isotopic species were reinvestigated including Q-branch transitions. The derived rotational constants, corrected for centrifugal distortion, are of higher accuracy than in earlier work. The resulting refined substitution structure of benzonitrile shows the same characteristic shortening of the ring bonds nearest to the substituent as in fluorobenzene. (auth)

37369 MICROWAVE SPECTRA OF ISOTOPIC THIAZOLES. MOLECULAR STRUCTURE AND ^{14}N QUADRUPOLE COUPLING CONSTANTS OF THIAZOLE. Nygaard, Lise; Asmussen, Erik; Hoeg, Jens H.; (and others) (Univ. of Copenhagen). J. Mol. Struct.; 8: No. 1-2, 225-33(Apr 1971).

Microwave spectra of thiazole and the eight monosubstituted isotopic species were investigated. For the parent and four substituted species the ^{14}N hyperfine structure was analyzed and the nuclear quadrupole coupling constants determined. These coupling constants were used to derive center frequencies for all except the ^{15}N species. The rotational constants were computed by least squares in the rigid rotor approximation. The substitution structure of thiazole is given and discussed. Except for the N,C(4) bond and its nearest angles, the thiazole molecule is very well described as a 1:1 composition of thiophene and 1,3,4-thiadiazole. (auth)

37370 ELECTROPHILIC SUBSTITUTION AT THE AROMATIC CARBON ATOM. ISOTOPIC EXCHANGE OF PENTAFLUORO PHENYLMERCURY BROMIDE WITH ^{203}Hg-LABELED MERCURIC BROMIDE IN DIMETHYL SULFOXIDE AND BENZENE. Beletskaya, I. P.; Zakharycheva, I. I.; Reutov, O. A. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 195: 837-40(1 Dec 1970). (In Russian).

Introduction of 5 fluorine atoms into the phenylmercury molecule increases the resistance of the compound against electrophilic attack. On the other hand, perfluorinated mercury compounds are subject to nucleophilic attack and in proton-donor solvents they suffer solvolytic decomposition. It was assumed that such an anion-catalyzed solvolytic decomposition is involved in the monomolecular electrophilic substitution reactions. The problem of the isotopic exchange of the pentafluorophenylmercury bromide with $^{203}HgBr_2$ in dimethyl sulfoxide (DMSO) was investigated in the concentration range of (0.25 to 2.67) × 10^{-3} mole/l at 40 to 60°C. It was assumed that the exchange in the $C_6F_5HgBr-{}^{203}HgBr_2-DMSO$ system follows a two-stage mechanism in which the limiting stage is the ionization of the C−Hg bond under the influence of DMSO. The results indicated that a $S_E1(N)$ mechanism is involved, whereby N designates DMSO, representing monomolecular electrophilic

substitution of the aromatic carbon atom. Attempts to carry out the reaction in benzene were unsuccessful. No exchange was noted at 50°C after 6 hours, but in the presence of bromide ions, the reaction took place even at 20°C at a faster rate than in DMSO. (TTT)

37371 VIBRATIONAL SPECTRUM OF SODIUM NITROPRUSSIDE. NORMAL COORDINATE ANALYSIS FOR THE $Fe(CN)_5NO^{2-}$ ION. Paliani, G.; Poletti, A.; Santucci, A. (Univ., Perugia, Italy). J. Mol. Struct.; 8: No. 1-2, 63-74(Apr 1971).

The analysis of the infrared and Raman spectra of $Na_2[Fe(CN)_5NO] \cdot 2H_2O$ has led to an assignment of the fundamental vibrations of the $Fe(CN)_5NO^{2-}$ ion, which is supported by studies of the infrared spectra of $Na_2[Fe(CN)_5{}^{15}NO] \cdot 2H_2O$, $Na_2[Fe(CN)_5NO] \cdot 2(H,D)_2O$, and $Na_2[Fe(CN)_5NO]$. A normal coordinate treatment (using a diagonal symmetry force field) has been carried out on the basis of a C_{4v} symmetry model for the anion. The significance of the resulting valence force constants is briefly discussed. (auth)

37372 ELECTROLYTE EFFECTS IN THE ISOTOPIC EXCHANGE BETWEEN ALKALI IODIDES AND METHYL IODIDE IN ETHANOL. Beronius, P.; Pataki, L.; Nilsson, A.-M.; Wikander, G. (Univ. of Umea, Sweden). Radiochem. Radioanal. Lett.; 6: No. 6, 333-7(31 May 1971).

Application of the Acree equation to kinetic data for the exchange of ^{131}I between methyl iodide and sodium, potassium, and rubidium iodide, respectively, in ethanol at 25°C, suggests that both free iodide ions and alkali iodide ion pairs undergo exchange with the organic halide. (auth)

37373 ELECTROLYTE EFFECTS IN THE ISOTOPIC EXCHANGE BETWEEN ALKALI IODIDES AND METHYL IODIDE IN PROPANOL. Holmgren, A.; Nilsson, A.-M.; Beronius, P. (Univ. of Umea, Sweden). Radiochem. Radioanal. Lett.; 6: No. 6, 339-43(31 May 1971).

The decrease in specific reaction rate with increasing electrolyte concentration in the isotopic exchange between alkali iodides (NaI, KI, RbI, and CsI) and methyl iodide in propanol at 25°C is interpreted in terms of different reactivities of free iodide ions and alkali iodide ion pairs. (auth)

37374 VIBRATIONAL SPECTRA OF LITHIUM TETRAMETHYLALUMINATE AND LITHIUM TETRAMETHYLZINCATE. Yamamoto, Jiro; Wilkie, Charles A. (Marquette Univ., Milwaukee). Inorg. Chem.; 10: No. 6, 1129-33(Jun 1971).

Infrared and Raman spectra of lithium tetramethylzincate, $Li_2Zn(CH_3)_4$, and lithium tetramethylaluminate, $LiAl(CH_3)_4$, and their isotopic analogs as solids were measured and assigned. In both complexes, Li–C stretching modes were observed at around 300 cm^{-1} in the ir spectra. The local symmetries of $Zn(CH_3)_4^{2-}$ and $Al(CH_3)_4^-$ ions are T_d and V_d (D_{2d}), respectively; $LiAl(CH_3)_4$ seems to form a linear chain analogous to $LiAl(C_2H_5)_4$. (auth)

37375 VIBRATIONAL SPECTRA OF B-TRIHALOBORAZINES. Blick, K. E.; Niedenzu, K.; Sawodny, W.; Takasuka, M.; Totani, T.; Watanabe, H. (Univ. of Kentucky, Lexington. Univ., Stuttgart. Shionogi and Co., Ltd., Osaka). Inorg. Chem.; 10: No. 6, 1133-40(Jun 1971).

The vibrational spectra of B-trihaloborazines, $(-BX-NH-)_3$, with X = Cl or Br, were examined and an assignment of the fundamentals is proposed. The data are supported by data obtained from boron-10 and deuterium labeled derivatives and a normal-coordinate treatment. (auth)

37376 MICROWAVE SPECTRUM, STRUCTURE, AND DIPOLE MOMENT OF 2-CARBAHEXABORANE(9), CB_5H_9. Cheung, Chung-chung S.; Beaudet, Robert A. (Univ. of Southern California, Los Angeles). Inorg. Chem.; 10: No. 6, 1144-8(Jun 1971).

The microwave spectrum of 2-carbahexaborane(9) was studied in the region of 8 to 37 GHz. The rotational spectra of the normal species (all ^{11}B isotope) and seven ^{10}B-substituted species were assigned. The principal axis coordinates of the boron atoms were calculated from the moments of inertia of the normal species and of the three singly substituted ^{10}B species. The results show that the main framework is a pentagonal pyramid. The following bond lengths were accurately determined: $r_{B(3)-B(4)} = 1.759$ Å, $r_{B(4)-B(5)} = 1.830$ Å, $r_{B(1)-B(3)} = 1.782$ Å, $r_{B(1)-B(4)} = 1.781$ Å. The Stark effect of the normal species and of two singly substituted B(10) species was measured. The molecular dipole moment was found to be 1.53 ± 0.03 D. (auth)

37377 ISOTOPIC OXYGEN EXCHANGE BY CATALYSTS IN THE V_2O_5–MoO_3 SERIES. Blanchard, Michel (Univ., Poitiers, France); Louguet, Gerard; Boreskov, G. K.; Muzykantov, V. S.; Panov, G. I. Bull. Soc. Chim. Fr.; No. 3, 814-19(Mar 1971). (In French).

The activation energy in the isotopic exchange of ^{18}O by V_2O_5–MoO_3 catalysts varies with the composition of the solid; it is maximum for an oxide containing 30% MoO_3. Also, this catalyst is the most selective one for the oxidation of butenes and benzene. (auth) (France)

37378 INTERNAL CONVERSION IN BENZENE, BENZENE-d_6, AND SULFUR DIOXIDE. Smith, Wm. Hayden (Princeton Univ., N. J.). J. Chem. Phys.; 54: No. 10, 4169-73(15 May 1971).

Lifetime studies of benzene and benzene-d_6 at pressures below 1 μHg, using an electron beam phase shift method, yield a lifetime of 73.5 ± 8.0 nsec for the measured levels of the $^1\tilde{B}_{2u}$ state of benzene and lifetimes varying from 89 ± 9 to 113 ± 11 nsec for essentially the same levels in benzene-d_6. From the measured absorption oscillator strength, the nonradiative processes depopulating the $^1\tilde{B}_{2u}$ state must proceed at a rate of $1.2 \pm 0.14 \times 10^7$ sec^{-1}. These results are compared with previous theory and experimental data. Radiative lifetime measurements for SO_2 were extended from those given previously and were reanalyzed with a model assuming spectral overlap of two different SO_2 upper states. This analysis is shown to be consistent with certain previous discussions of the emission spectrum and, in particular, with those of Douglas[3] concerning the anomalous lengthening of the $^1\tilde{B}_1$-state radiative lifetime. (auth)

37379 MOTIONS OF PROTONS IN CH-, CH_2-, CH_3-, AND C_2H_5-HALIDES BY COLD NEUTRON TRANSMISSION EXPERIMENTS. Fischer, C. O. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Phys. Chem.; 75: No. 3-4, 361-5(Apr 1971).

Total cross sections of CH_3I, CH_2DI, CH_3CH_2I, CD_3CH_2I, CH_3CD_2I, CH_2I_2, CH_2Br_2, and $CHBr_3$ were measured with cold neutrons between 4 and 17 Å. The slopes S of the scattering cross section per proton vs. the neutron wavelength indicate the different types of protonic motions in the investigated liquids. The high slope S = 12.6 ± 0.4 barn/Å for protons in CH_3I is explained by relative free internal rotation of the methyl group. This rotation is not influenced by the substitution of a proton by a deuteron as in CH_2DI ($S = 12.6 \pm 0.4$ barn/Å). But the motion of the protons becomes strongly hindered by increasing the rotational mass when substituting a proton by a halide nucleus as in CH_2I_2 ($S = 5.6 \pm 0.5$ barn/Å) and in CH_2Br_2 ($S = 6.2 \pm 0.5$ barn/Å). In $CHBr_3$ no internal molecular motion of the proton is possible and the low cross section slope $S = 2.0 \pm 0.8$ barn/Å shows that the rotations of the $CHBr_3$ molecules are much more hindered than rotations of CH_2Br_2. In CH_3CH_2I the neutron-proton scattering is weaker than in CH_3I. Comparison of the CD_3CH_2I and CH_3CD_2I cross sections with the CH_3CH_2I result indicates within the experimental errors no difference between the scattering power of methyl and methylene protons in ethyl iodide. This leads to the conclusion that all protons in ethyl iodide participate in the same microdynamic process, which exchanges momentum and energy with the cold neutron. Therefore, an internal rotation of the ethyl group around the C–I bond is assumed. (auth)

37380 SPECTROSCOPIC AND KINETIC STUDY OF ISOTOPE EXCHANGE OF ALCOHOL AND AMINE HYDROGEN WITH MERCAPTANS IN SOLUTION. Bureiko, S. F.; Denisov, G. S.; Tokhadze, K. G. (Leningrad State Univ.). Kinet. Katal.; 12: No. 1, 62-5(Jan-Feb 1971). (In Russian).

Infrared absorption spectra were used to determine the velocity of isotope exchange of the H of various alcohols and amines with the deuterium of C_6H_5SD in CCl_4 solution. The kinetics of the H–D exchange revealed the bimolecular nature of the reaction, and the existence of a hydrogen-bonded cyclic complex is suggested, whereby a cooperative transition of protons is facilitated. The energy of activation of the isotope exchange was found to lie in the range 3 to 5.5 kcal/mole for four of the simpler aliphatic alcohols, and in the range 6 to 8 kcal/mole for a number of the amines. The velocity constants of the reactions are discussed in the light of the capacity of the alcohols and amines to function as proton donors or acceptors. (K.S.W.)

37381 SOLVENT ISOTOPE EFFECTS ON THE CHEMICAL SHIFTS OF COMPLEX FLUORO IONS IN H_2O AND D_2O SOLUTIONS. Radley, K.; Reeves, L. W. (Univ. of Waterloo, Ont.). J. Chem. Phys.; 54: No. 10, 4509-10(15 May 1971).

A survey was made of infinite dilution isotope shifts between H_2O–D_2O systems for a series of ions. For all ions where the first coordination sphere is not penetrated, the solvent isotope shifts are relatively small. They are fairly large, however, compared to previously reported fluorine isotope shifts in unrelated systems. The isotope shifts depend on the ionic charge for the outer sphere effect. An increasing solvent isotope chemical shift, as the number of inner sphere water molecules increases, was observed. The simple F^- ion shows the largest solvent isotope effect of all. (M.C.G.)

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37382 ISOTOPE EXCHANGE BETWEEN OXYGEN AND STANNIC OXIDE. Dzeventski, Z.; Muzykantov, V. S. (Silesian Polytechnic Inst., Pol'sha, USSR. Inst. of Catalysis, Novosibirsk, USSR). Kinet. Katal.; 12: No. 1, 207-11(Jan-Feb 1971). (In Russian).

The kinetics of the isotopic exchange between molecular oxygen and SnO_2 were investigated at 11 mm Hg and between 500 and 700°C. The initial mixture of oxygen isotopes contained 50 at. % ^{18}O and the progress of the reaction was followed by means of a mass spectrometer. The reaction rate as a function of temperature could be written: rate = 2.6×10^{20} exp (−35,500/RT), wherein 35.5 kcal/mole represents the activation energy for the exchange reaction. The role of various possible reaction mechanisms is discussed. (K.S.W.)

37383 SUBSTITUENT AND SECONDARY DEUTERIUM ISOTOPE EFFECTS FOR HYDROLYSIS OF SCHIFF BASES. Archila, Josefina; Bull, Herbert; Lagenaur, Carl; Cordes, E. H. (Univ. Central, Caracas. Indiana Univ., Bloomington). J. Org. Chem.; 36: No. 10, 1345-7(21 May 1971).

The inverse kinetic secondary deuterium isotope effect, k_D/k_H, for attack of hydroxide ion on the conjugate acids of substituted N-benzylidene-1,1-dimethylethylamines is near 1.22 and is independent of the nature of the polar substituent. The same isotope effect for the attack of water on the conjugate acid of N-4-methoxybenzylidene-1,1-dimethylethylamine is 1.20. Thus, transition states for these reactions resemble the adducts more closely than the substrates. Second-order rate constants for the attack of hydroxide ion on substituted N-(substituted)-benzylideneanilines are correlated by the Hammett σ constants. Values of ρ near 2.7 were obtained in all cases except for the Schiff bases derived from 4-nitrobenzaldehyde, for which a value of 1.9 was found. These large values are consistent with adduct-like transition states for Schiff base hydrolysis. (auth)

37384 DEUTERIUM ISOTOPE EFFECT IN OCTAHEDRAL SUBSTITUTIONS. V. THE MERCURY(II)-INDUCED AQUATION OF SOME cis-CHLORO(AMINE)BIS-(ETHYLENEDIAMINE)COBALT(III) CATIONS IN DEUTERIUM OXIDE. Chan, S. C.; Chan, S. F. (Univ. of Hong Kong). Aust. J. Chem.; 24: 895-8(Apr 1971).

The deuterium isotope effect on aquation of cis-$[Co(en)_2(RNH_2)Cl]^{2+}$ cations showed higher rates when Hg^{2+} was present than for spontaneous aquation. An isotope effect of 0.67 was obtained, averaged over values for R = H, Me, Et, Pr^n and Pr^i compared with $k^H/k^D = 1.4$ for spontaneous aquation. (Australia)

37385 INTERNAL ROTATION IN $(CH_3)_2X$ MOLECULES OF C_{2v} SYMMETRY: BARRIER TO INTERNAL ROTATION IN DIMETHYL ETHER. Tuazon, Ernesto C.; Fateley, William G. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 54: No. 10, 4450-4(15 May 1971).

A procedure is described for calculating the periodic barrier to internal rotation of C_{2v} molecules with two methyl groups based on one observed torsional frequency for each of the isotopic species $(CH_3)_2X$ and $(CD_3)_2X$. The method is applied to dimethyl ether using the observed gas-phase B_1 torsional frequencies of $(CH_3)_2O$ and $(CD_3)_2O$. The calculated coefficients of the potential function are $V_{effective} = 946 \pm 15$ cm^{-1} and $V_{12} = 30 \pm 9$ cm^{-1}. The evaluation of the threefold barrier (V = 907 cm^{-1}) for the isotopic species CH_3OCD_3 suggests that the CH_3 and CD_3 torsional levels are in resonance. Comparison of the results for the three isotopic species allows the value of V_{12} to be estimated as −20 cm^{-1} (auth)

37386 KINETICS OF INHIBITION OF HYDROCARBON AUTOXIDATION BY 1,1'-BIS(N-PHENYL-2-NAPHTHYLAMINE). Bridger, R. F. (Mobil Research and Development Corp., Princeton, N. J.). J. Org. Chem.; 36: 1214-16(7 May 1971).

The kinetics of inhibition of cumene autoxidation at 60° by 1,1'-bis(N-phenyl-2-naphthylamine), a sterically hindered amine, are reported. The stoichiometry of inhibition indicates consumption of two peroxy radicals per amino group. The deuterium isotope effect $[k_5(H)/k_5(D)]$ is 3.6 in the rate-determining hydrogen transfer step. This hydrogen transfer is unusually slow ($k_5 = 1320$ M^{-1}sec^{-1}), and the kinetics suggests an abnormally fast reverse reaction. Experiments with inhibited autoxidations of tetralin indicate that the inhibitor radicals abstract hydrogen atoms from the hydrocarbon. The failure of steric hindrance about the amino group to reduce hydrogen abstraction reactions by inhibitor radicals stands in strong contrast to experience with hindered phenols. (auth)

37387 PROTON SPIN RELAXATION OF ADSORBED METHANE. II. ISOTOPE EFFECT. Beckert, Dieter (Karl-Marx Univ., Leipzig). Z. Phys. Chem. (Leipzig); 246: No. 3-4, 155-60(1971). (In German).

In order to determine the various relaxation contributions to the measured relaxation rate of species adsorbed on solid surfaces the partially and completely deuterated adsorbate molecules are often included in the NMR experiments and a primary isotope effect is supposed. In the system methane−silica gel an isotope effect of higher order occurred, which can be explained by assuming that the correlation time of the adsorbed methane molecules is a linear function of the number of D-atoms per $CH_{4-n}D_n$-molecules. An isotope factor, η, of this effect is introduced and the dependence of η on coverage and temperature, respectively, can be obtained. The values of η are, approximately by a factor two, greater than results obtained by other authors. (auth)

37388 HYDROGEN ISOTOPE EXCHANGE IN α-BROMOALLENES. Mavrov, M. V.; Rodionov, A. P.; Kucherov, V. F. (Inst. of Organic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 4, 885-7(Apr 1971). (In Russian).

A series of three 1-bromo-substituted allenes were treated with D_2O in the presence of NaOD, obtaining deuterium replacement for H on the carbon holding the Br. For the two compounds: 1-bromo-3-hydroxymethylallene and 1-bromo-3-dimethylaminomethylallene, 3 hours standing at room temperature sufficed for 80 to 90% exchange. In contrast, 16 days standing at room temperature produced only 50 to 60% exchange in the compound 1-bromo-3-ethyl-3-methylallene. (K.S.W.)

Physical Chemistry

Refer also to abstracts 37438, 37469, 37492, 38014, and 38019.

37389 (BM-RI-7528) ELECTRICAL CONDUCTIVITY AND DENSITY OF FLUORIDE SYSTEMS. Meaker, Reginald E.; Porter, Bernard; Kesterke, D. G. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). Jun 1971. 20p.

Electric conductivities and densities of molten fluoride systems were measured as functions of the melt temperature and composition. For any given mixture, the two properties change linearly with temperature. Three alkali metal fluorides were selected as solvents for melts of the type LiF−, NaF−, and KF−MF_x, where M is a metal selected from the alkali metal or alkaline earth groups, or from the lanthanide or actinide series of elements, and x = 1 to 4. Heats of activation for conductance were calculated from the experimental data and varied from 2.3 to 9.2 kcal/mole at 1,000°C. Some relation between position in the phase diagram and the conductivity changes was suggested. (auth)

37390 SOLVATION OF UO_2Cl_2 BY TRIBUTYL PHOSPHATE. Fomin, V. V.; Lipis, L. V.; Averbakh, L. I.; Maiorova, E. P.; Leman, G. A. Zh. Neorg. Khim.; 16: No. 3, 772-5(Mar 1971). (In Russian).

The existence of the disolvate $UO_2Cl_2 \cdot 2TBP$ was confirmed by extraction of UO_2Cl_2 by mixtures of TBP−CCl_4−$C_2H_4Cl_2$ or heptane. Removal of CCl_4 from a solution of UO_2Cl_2 in 0.2 molar TBP in CCl_4 causes the separation of a compound corresponding to the formula $UO_2Cl_2 \cdot 2TBP$. The spectrum of the latter is strongly influenced by the nature of the diluent, but these deviations do not indicate solvate formation with TBP other than the disolvate. Cryoscopic studies show that only the disolvate exists in the system $UO_2Cl_2 \cdot 2TBP$−TBP. (tr-auth)

37391 STUDIES ON PRECIPITATION AND CO-PRECIPITATION OF TANTALUM AND NIOBIUM FROM POTASSIUM FLUORIDE SOLUTIONS. Herak, M. J.; Diksic, M.; Strohal, P. (Inst. Rudjer Boskovic, Zagreb). Mikrochim. Acta; No. 1, 116-20 (1971).

Precipitation and coprecipitation of Ta and Nb from KF solutions were investigated under various experimental conditions. Variations of HF concentration do not influence the K_2TaF_7 precipitation yield, but variations in KF concentration do. Nb coprecipitation is mainly due to adsorption on the surface of the solid phase. Chemical composition of the K_2TaF_7 was checked by neutron-activation analysis. (auth)

37392 METHOD OF PREPARING BERYLLIUM NITRATE SOLUTIONS. Godesiabois, Paul T. (to United States Atomic Energy Commission). U. S. Patent 3,574,533. 13 Apr 1971. Filed 13 May 1969.

A method for obtaining beryllium nitrate solutions comprising first dissolving beryllium in a methyl alcohol−carbon tetrachloride mixture, filtering the resulting solution, evaporating the filtrate to a dry residue, and dissolving the residue in nitric acid is presented. (Offic. Gaz.)

37393 DISSOCIATING GASES: A NEW CLASS OF COOLANTS AND WORKING SUBSTANCES FOR LARGE POWER PLANTS. Krasin, A. K.; Nesterenko, V. B. (Nuclear Power Inst., Minsk). At. Energy Rev.; 9: No. 1, 177-94(Apr 1971).

Scientific and technical principles underlying the use of dissociating gases as coolants and working substances in nuclear

power stations are discussed. Data are given on the thermophysical properties of N_2O_4, Al_2Cl_6, and Al_2Br_6 and also on the corrosion resistance of structural materials in an N_2O_4 medium. Theoretical parameters are given for the thermodynamic cycles, for turbines operating with dissociating gases and for the physical characteristics of fast-neutron reactors cooled by dissociating-gas coolants. Experience gained on experimental plants using N_2O_4 is described and the advantages of dissociating-gas coolants are examined in relation to their use in nuclear power stations operating at maximum capacity limits. (auth)

37394 FURNACE FOR THE DETERMINATION OF SOLUBILITY AND DENSITY OF METAL–MOLTEN SALT SYSTEMS BY MEANS OF THE RADIATION ABSORPTION METHOD. Moscinski, J. (Inst. of Nuclear Techniques, Krakow). Radiochem. Radioanal. Lett.; 6: No. 6, 359-62(31 May 1971).

A resistance-heated furnace is described, which may be used for measuring the γ-absorption of liquid samples at temperatures up to 1300°K. (auth)

37395 ENERGY LEVELS AND STRUCTURE OF AMMONIUM URANYL FLURORIDE. Garg, C. L.; Narasimham, K. V. (Defence Science Lab., Delhi). Spectrochim. Acta, Part A; 27: No. 6, No. 6, 863-75(Jun 1971).

The energy levels of ammonium uranyl fluoride [$(NH_4)_3UO_2F_5$] were established from investigations of Raman, infrared, fluorescence, and electronic absorption spectra of the compound and the fluorescence and electronic absorption spectra were analysed on the basis of these frequencies. From the vibrational frequencies U–O force constant and bond distance were calculated. A schematic diagram of crystal structure, showing the positions of the various atoms in the compound was given. Besides the uranyl frequencies, fundamentals due to ammonium ion and crystal lattice were obtained in fluorescence, electronic absorption, and Raman spectra. A very good agreement was obtained between the values of the various fundamental frequencies from the different investigations. Energy level diagrams showing various transitions in fluorescence and electronic absorption spectra are given. (auth) (UK)

37396 QUANTUM CHEMISTRY OF SUPER-ACTINIDE ELEMENTS. Waber, James T. (Northwestern Univ., Evanston, Ill.). pp 353-443 of Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research. XIII. /Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970).

From Robert A. Welch Foundation conferences on chemical research. XIII. The transuranium elements; Houston, Tex. (17 Nov 1969). See CONF-691124.

The basis of making calculations of electronic structure is discussed in terms of the angular and then the radial properties of Dirac's equation. Various consequences of using a relativistic treatment of electrons are presented. The bridge between chemical stability and nuclear stability is considered. Results of experiments in "computer chemistry" are given. Quantum chemistry, solution of the radial equations, nuclear structure and closed shells, and electronic structure are discussed. (M.C.G.)

37397 IDENTIFICATION OF THE LOWER TRANSITIONS IN THE SPECTRA OF URANYL COMPLEXES. Goerller-Walrand, C.; Vanquickenborne, L. G. (Univ. Leuven, Heverlee, Belgium). J. Chem. Phys.; 54: No. 10, 4178-86(15 May 1971).

The typical low-energy spectra of the uranyl complexes, both in solution and in the solid state, are interpreted by using group theory and qualitative molecular orbital theory. A comparative study of the effects of ligation on the spectrum shows that the observed facts can be rationalized by means of only one possible identification scheme. The band system situated at 20,000–22,000 cm^{-1} is due to a $^1\Sigma_g^+ \rightarrow {}^1\Phi_g$ transition, while the band system at 22,500–27,000 cm^{-1} is due to a $^1\Sigma_g^+ \rightarrow {}^1\Delta_g$ transition. (auth)

37398 THERMAL CONDUCTIVITY OF HEAVY WATER (D_2O). Venart, J. E. S.; Mani, N. (Univ. of Calgary, Alberta). J. Mech. Eng. Sci.; 13: No. 3, 205-16(Jun 1971).

Existing thermal conductivity (λ) data for heavy water between 0 and 600°C at pressures from atmospheric to 1000 bar are correlated as simple functions of reduced pressure and temperature, utilizing orthogonal polynomial least squares analysis. Correlations in the vapour and supercritical states are made from a knowledge of the ratio $\lambda_{D_2O}/\lambda_{H_2O}$. A table of best values for the liquid, vapour, and supercritical states of the pure fluid is also provided. Using these values, the thermal conductivity of heavy water can be estimated to between ±2 and ±10 percent from values of pressure and temperature only. (auth) (UK)

37399 ENTHALPY OF SATURATED HEAVY WATER LIQUID. Nowak, E. S. (Univ. of Western Ontario, London, Can.). Eng. J. (Montreal); 54: No. 5, 1-4(May 1971).

Information on the enthalpy of heavy water is essential in the estimation of the size and capacity of heavy water circulation pumping equipment and heat exchangers of pressurized heavy water cooled nuclear power stations. Conflicting values for this quantity are reported in the literature. The construction of an apparatus to obtain reliable measurements for the enthalpy change of saturated heavy water liquid from 480 to 560°F is described. (F.S.A.)

37400 SYMMETRY OF CRYSTALLINE UTe_2. Ellert, G. V.; Eliseev, A. A.; Slovyanskikh, V. K. (Inst. of Advanced Chemical Technology, Moscow. Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 16: No. 5, 1451-2 (May 1971). (In Russian).

Monocrystalline UTe_2 was prepared by a gas-transport reaction, using bromine as a carrier, and retrieving the compound in the 800 to 900°C zone. A structural study of the monocrystalline UTe_2 was conducted, yielding the lattice constants: a = 6.16, b = 4.24, and c = 14.52, indicating a rhombic system, with 4 formula units (UTe_2) per elementary cell. The crystal density was 8.68 g/cm^3. (K.S.W.)

37401 METHOD FOR PREPARING URANIUM-CONTAINING AQUASOLS EMPLOYING A PLATINUM OXIDE CATALYST. Pattison, William L.; McBride, John P. (to United States Atomic Energy Commission). U. S. Patent 3,575,875. 20 Apr 1971. Filed 1 May 1969.

A platinum oxide catalyst, which has the unique property of becoming highly flocculated in the reduced state, is employed in an improved method for preparing stable U-containing aquasols from U(VI)-containing feed solution, which is catalytically reduced by hydrogen to a U(IV)-containing solution in a flow-through reductor vessel. The reduced platinum oxide catalyst is readily retained in the reductor vessel on a porous filter, and the U(IV)-containing solution is then processed into a stable U-containing aquasol and calcined UO_2 microspheres by known sol-gel processes. (Offic. Gaz.)

37402 U(VI) COMPLEXES OF OXINE AND DERIVATIVES. Corsini, A.; Abraham, J.; Thompson, M. (McMaster Univ., Hamilton, Ont.). Talanta; 18: No. 5, 481-90(May 1971).

Infrared bands due to the hydrogen-bonded $^+N-H\cdots O$ system in the oxine adduct of U(VI) were identified and found to occur in the spectra of newly prepared U(VI) adducts of oxine derivatives. Interligand steric effects in the U(VI) complexes of most 7-substituted oxines prevent the formation of the 1:3 adduct. Complexes of the type ML_2X, where X is a small co-ordinating species present in solution, are formed instead. With 2-substituted oxines, steric interactions between the 2-substituent and co-ordinated water result in destabilization of the complex and subsequent hydrolysis as the pH of the solution is raised. Experiments involving the use of [^{14}C]-oxine were found to distinguish between co-ordinated and lattice-held oxine and are potentially valuable in studies of oxine adducts formed by other metal ions. (auth) (UK)

Radiation and Nuclear Chemistry

Refer also to abstracts 37814, 37826, and 37863.

37403 (ANL–7770, pp 55-75) BIOCHEMISTRY. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

Research progress is reported on: stable isotope analysis of organic molecules using gas chromatography and mass spectroscopy, analysis of deuterium-labeled compounds, phospholipase A in mammalian cells, membrane-bound enzymes, activation analysis of biological membranes, deamination of adenosine sulfur compounds, γ radiation effects on mice, biochemistry of catalase, and cytological effects of lethal x irradiation on yeast cells. (M.C.G.)

37404 (EUR–4612, pp 43-60) PRODUCTION AND PROPERTIES OF TRANSURANIUM ELEMENTS. Mueller, W. (European Inst. for Transuranium Elements, Karlsruhe (West Germany)).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Transuranium elements can be formed from uranium by neutron irradiation or by bombardment with heavy ions. Atomic numbers, Z, of up to about 100 can be obtained by slow build-up in a nuclear reactor, in which neutron absorption alternates with beta decay. In neutron showers of nuclear explosions, heavy isotopes of the

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initial nucleus are formed by the simultaneous absorption of several neutrons; successive beta decays transform these into nuclei of higher atomic numbers. The heaviest nuclei yet synthesized (Z = 101 to 105) were obtained by bombardment with heavy ions in an accelerator. The half-lives of the transuranium elements, which up to Z = 103 belong to the actinide series, decrease with increasing atomic numbers. More recent calculations indicate, however, that nuclides with longer half-lives might be expected in the transactinides with atomic numbers around 110 and 114. The applications of some transuranium nuclides are based on their nuclear properties, especially alpha decay, spontaneous fission, and fissionability by neutrons. The chemical properties are determined by the oxidation stages of the first transuranium elements. The analogy of the actinides with the, mainly trivalent, lanthanides becomes apparent only from Cm onwards. Element 104, the first transactinide, is an Eka-Hf. The nuclear and chemical properties of the transuranium elements and their toxicity require: simple separation processes (ion exchange, extraction, extraction chromatography); special operating techniques (microtechniques, remote control, shielding, glove boxes), and solution of special problems such as radiolysis, decay heat, and criticality. (auth)

37405 THERMAL IGNITION AND STABILITY OF BATCH REACTORS WITH NONUNIFORMLY-INITIATED RADIATION-INDUCED REACTIONS. Shendalman, L. H. (Yale Univ., New Haven); Hill, F. B. Chem. Eng. Sci., Suppl.; 449-58(1971).

From fourth European symposium on chemical reaction engineering; Brussels, Belgium (9 Sep 1968). See CONF-680987.

For chain reactions with biradical termination, the Frank–Kamenetskii conductive theory of thermal ignition is extended to include the explicit spatial dependence arising from nonuniform photoinitiation. The extended theory and a corresponding normal mode analysis indicate that the nonuniform initiation, if anything, confers additional stability. Neglect of thermal convection results in conservative design criteria. (auth) (UK)

37406 PRACTICAL ASPECTS OF AIR RADIATION CHEMISTRY. Dmitriev, M. T. (Inst. of Public and Social Health, Moscow). Izotopy SSSR; No. 17, 11-16(1970). (In Russian).

Practical aspects of air radiation chemistry are discussed. Special studies were made of atmospheric nitrogen fixation, air conditioning, sterilization of warehouses, and γ sterilization of water and food products. (tr-INIS)

Radiation Effects

37407 (UJV-2415-Ch) EFFECT OF GAMMA RADIATION ON SORPTION PROPERTIES OF ISOMORPHOUS CALCIUM BARIUM SULPHATE: A SELECTIVE SORBENT FOR Sr IONS. Vojtech, O.; Moravec, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 14p. (In Czech). NTIS (U. S. Sales Only).

Selective sorbents for Sr ions based on isomorphous metastable calcium barium sulfates were found to decompose under the influence of high gamma radiation doses to the original components. The $CaSO_4$ thus formed reacted with water; the absorption band in the ir spectrum region of the resulting hemihydrate was used for a quantitative investigation of the radiolysis. With increasing dose (up to 10^9 rad) the sorption efficiency for Sr decreased. This was evidenced by a decrease both in the maximum amount sorbed and in the sorption rate. However, if the Purex process should be used for purification of radioactive wastes and the beta and gamma radiation dose rate will not exceed several rads per hour, no considerable effect of radiation on the sorption capacity can be expected. (INIS)

37408 EFFECT OF ^{228}Th ON THE CATALYTIC PROPERTIES OF THORIA. Beaumont, Maurice (CNRS, Villeurbanne, France). Ann. Chim. (Paris); 5: 385-96(Sep-Oct 1970). (In French).

The effects of ^{228}Th on the structural, electronic, and catalytic properties of thoria, obtained by the pyrolysis of thorium nitrate or oxalate, were investigated. The dimensions of the unit cell increased, the ir absorption bands shifted, an absorption band appeared in the uv, and the electrical and magnetic properties were modified. Annealing at 500° suppressed the lattice effects which reappeared slowly. A differential dynamic reactor was set up which allowed this catalytic activity to be measured in the oxidation of carbon monoxide reaction. Thus, for the first time, experimental support for the Wolkenstein and Baru theory was obtained. (France)

37409 ELECTRICAL CONDUCTIVITY OF BIOLOGICAL AND ORGANIC COMPOUNDS. PART IV. ELECTRICAL CONDUCTIVITY IN POLYCAPROLACTAM OF DIFFERENT MOLECULAR WEIGHT BEFORE AND AFTER GAMMA IRRADIATION. Breccia, Alberto; Dellonte, Sergio; Nucifora, Giuseppina (CNR, Bologna). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 68: 630-5(Jun 1970).

The conduction mechanism of polycaprolactam was investigated at temperatures below 70°C, and the function of molecular weight in the electric conductivity before and after γ irradiation was also investigated. The data indicated an increase in the bulk resistivity of the material after successive cooling and heating cycles without variation in the activation energy. After irradiation, the resistivity of each sample decreased but again reached the value of non-irradiated ones after the first heating cycle. Radical population appeared after irradiation and varied slowly with the applied electrical field, and the kinds of radicals indicated would support a theory of proton motion inside the molecules. Resistivity decreased with increasing molecular weight and is probably due to different quantities of absorbed water in the samples. (B.L.M.)

Radiation Processes

37410 (AEC-tr-7102/3) NUKLEONIKA. Translation of Nukleonika; 15: No. 3, 237-316(1970). 74p. (TT-70-55010/3). Dep. NTIS.

37411 KINETICS OF DEHYDROCHLORINATION OF POLY(VINYLIDINE CHLORIDE). PART 2. EFFECT OF PRE-IRRADIATION WITH U.-V. AND γ-RAYS AND THE INFLUENCE OF THE CHEMICAL NATURE OF THE AMBIENT ATMOSPHERE. Everett, D. H.; Taylor, D. J. (Univ. of Bristol, Eng.). Trans. Faraday Soc.; 67: 402-13(Feb 1971).

Work on the influence on the kinetics of the first stage of decomposition of solid poly(vinylidene chloride), indexed as dichloroethylene polymers, of pre-irradiation with uv and γ-radiation, and of the chemical nature of the ambient atmosphere (vacuum, N_2, air, O_2, HCl, NO, ethylene, propylene, water vapor) is reported. The results lend support to the mechanism of the reaction suggested previously (Trans. Faraday Soc., 67: 382-401). (UK)

37412 IRRADIATED METAL-POLYMER COMPOSITIONS. Saunders, Frank L.; Rieke, James K.; Twining, James W. (to Dow Chemical Co.). U. S. Patent 3,567,607. 2 Mar 1971. Filed 18 Feb 1966.

A composition useful for fabricating an article having improved tensile and impact strength comprises at least 40 vol % of an irradiated olefin polymer, such as polyethylene, and at least 40% by volume of finely divided metallic particles, such as Al. The composition is prepared by dry-blending the irradiated polymer and the metallic particles to form a uniform mixture. The mixture is then formed into the article desired by, for example, a suitable molding technique. (Offic. Gaz.)

37413 MUTUAL IRRADIATION GRAFTING OF STYRENE ONTO POLY(VINYL ALCOHOL) AND THE CHARACTERIZATION OF THE GRAFT COPOLYMER. Ikada, Yoshito; Horii, Fumitaka; Sakurada, Ichiro (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 49: No. 1, 6-13(Jan 1971).

Styrene was graft-copolymerized to poly(vinyl alcohol) (PVA) films in the presence of methanol by means of mutual irradiation. Methanol was found to promote the grafting and to increase the molecular weight of polystyrene. The latter result was different from that found in the grafting of methyl methacrylate. The length of the branch was very high, but could be reduced by an addition of carbon tetrachloride to such an extent that the length of the branch became comparable with that of the backbone polymer. The graft copolymer was isolated from the grafting product by vigorous extraction of homopolystyrene and unreacted PVA. The G-value for the graft branch formation was found to be 1.3, which was comparable with the G_R-value for the radical formation of PVA. Isolation of the branch polystyrene from the backbone and determination of the number-average molecular weights led to the conclusion that the graft copolymer consists of one mother PVA and one branch polystyrene. (auth)

37414 RADIATION-INDUCED VAPOR-PHASE GRAFTING OF METHYL METHACRYLATE ONTO POLY(VINYL ALCOHOL). Ikada, Yoshito; Nishizaki, Yasuko; Sakurada, Ichiro (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 49: No. 1, 1-5(Jan 1971).

Vapor-phase grafting of methyl methacrylate (MMA) was carried out at 60°C onto poly(vinyl alcohol) (PVA) by mutual irradiation technique. Dry or water-swollen films were placed above pure monomer or monomer-swelling agent mixture in sealed glass ampoules and irradiated with γ rays to a dose of 1.1×10^6 R. When the grafting was carried out onto dry films, no appreciable weight increase was observed in the case of the absence of swelling agents in the monomer. However, grafting took place when methanol or water was added to the monomer. On the other hand, in the case of the grafting onto water-swollen films, high values of percent graft were attained, irrespective of

the presence of the swelling agent. The molecular weights of homo-PMMA formed in the films were lower by one order than those obtained in liquid-phase graftings. (auth)

37415 MODIFICATION OF THE PROPERTIES OF POLYETHYLENE AND POLYPROPYLENE BY RADIATION-INITIATED VINYL CHLORIDE GRAFTING FROM THE GAS PHASE. Kurbanov, Sh. A.; Usmanov, Kh. U.; Tillaev, R. S. (Tashkent State Univ.). Acta Chim. Acad. Sci. Hung.; 67: No. 3, 321-37(1971). (In Russian).

The radiation-chemical grafting of vinyl chloride from the gas phase into low- and high-density polyethylene and polypropylene foils, and fibers made from them, was studied. The dependence of the graft-copolymer yield on the dose and dose rate and on the solvent was established. The rate of graft-copolymerization is a function of the 0.45 and 0.46-th powers, respectively, of the dose rate. The physicochemical and mechanical properties, such as thermal stability and light stability, were studied, together with DTA and electric measurements on the original and modified samples. The kinetics of thermal decomposition of the graft-copolymers was investigated. As demonstrated by elemental analysis, the residue after pyrolysis is mainly carbon and hydrogen. It was shown by mass spectrometry that the chief volatile products are hydrogen chloride, methane, ethane, propane, butane, pentane, hexane, heptane, and unsaturated hydrocarbons. The possibilities of improving the chemical, thermal, and radiation-chemical properties and light stability of polyethylene and polypropylene are discussed. These properties are affected by the amount of grafted polyvinyl chloride. (auth)

37416 POLAROGRAPHIC STUDY OF THE X-RAY-INDUCED REDUCTION OF URANYL IONS IN AQUEOUS SOLUTION. Ohno, Shin-ichi; Sasaki, Teikichi (Japan Atomic Energy Research Inst., Tokai). Radioisotopes (Tokyo); 20: No. 5, 211-16(May 1971).

A polarographic method was applied to the determination of the change in concentration of uranyl ions in aqueous acetic acid, oxalic acid, and HCl solutions under 40-kV x irradiation. In CH_3COOH (0.1 M) and HCl (0.05 N) solutions, no reduction of U(VI) was observed. In oxalic acid media, the uranyl ion was reduced to U(IV) on irradiation. The yield of the reduction increased with an increase in the concentration of oxalic acid ($G(U(IV)) = 2.6$ at $[H_2C_2O_4] = 0.5$ M). The results of the radiation effect could be understood in terms of reactions of OH radicals and hydrated electrons with oxalic acid. The resulting organic radicals then react with the uranyl ion. By examining the effect of chloride ion on the x-ray-induced reduction of U(VI) in $H_2C_2O_4$ solution, it was also concluded that the rate constant ratio $k(OH + H_2C_2O_4)/k(OH + Cl^-)$ is 1.3 at pH = 1.5. (auth)

37417 ANALYSIS OF RADIATION GRAFTING BY MEANS OF ACTIVATION ANALYSIS. Yasukawa, Tamio; Takahashi, Tohru; Sasaki, Yasunori (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 1, 146-8(Oct 1970). (In Japanese).

Activation analysis was used to analyze radiation grafting. Polyethylene was activated by electron irradiation. Activated polyethylene was introduced into styrene. After a fixed time, carbon tetrabromide was introduced into the system in order to label surviving active points with bromine. The bromine in the grafted polymer obtained was radioactivated by neutron irradiation, and its quantity was determined. For comparison, the same experiment was also carried out with benzene instead of styrene. The G value of the active points thus determined was 0.3. The number of the active points decreased rapidly with increasing grafting time in the polyethylene–styrene system, while it first decreased, then increased, and again decreased with increasing swelling time in the polyethylene–benzene system. The propagation rate of grafting was determined as a function of grafting time. (Japan)

37418 RADIATION-INDUCED REACTIONS WITH CELLULOSE. IX. COPOLYMERIZATION WITH STYRENE USING A PRE-IRRADIATION PROCEDURE AND THE EFFECT OF ADDITIVES ON THE GRAFTING REACTION. Dilli, S.; Garnett, J. L. (Univ. of New South Wales, Kensington, Australia). Aust. J. Chem.; 24: No. 5, 981-7(May 1971).

The results of a study of grafting to pre-irradiated cellulose are presented using the monomers styrene, vinyl acetate, and 2- and 4-vinylpyridines. The effect of pre-irradiation dose was examined over the range 1 to 10 Mrad in air at dose rates of 0.114 to 1.16 Mrad/hr. Of a number of additives included in the grafting solutions, small amounts (10^{-2}M) of acridine completely suppressed grafting, anthracene inhibited it, and the halobenzenes produced a sensitization in the reaction. (auth)

37419 RADIATION INDUCED GRAFT COPOLYMERIZATION. Das Gupta, Sharda; Slobodian, James Theodore (to Atomic Energy of Canada Ltd.). U. S. Patent 3,567,606. 2 Mar 1971. Priority date 24 Jul 1963, Canada.

Vinyl monomers, such as styrene or methyl methacrylate, were graft polymerized onto porous rolls of fabrics, filaments, or threads of materials such as nylon, jute, linen, rayon, cotton, or paper. The linear shaped material was polymerized in a rolled condition of multiple convolution so that the outer convolutions could be separated from the inner convolutions to yield articles containing an insignificant concentration of undesired homopolymer. (B.L.M.)

Radiolysis

Refer also to abstracts 37602, 38562, and 38571.

37420 (BNWL–1551(Pt.2), pp 70-1) CHARACTERIZATION OF RADITION-INDUCED FREE RADICAL REACTIONS IN AQUEOUS SYSTEMS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

Chemical structures and reactivities of free radicals formed in irradiated model systems were determined in order to understand and alleviate the development of radiobiological damage. Electron spin resonance spectroscopy and optical absorption spectrophotometry were used to identify the radicals and determine the kinetics of their reactions with other biochemical substrates in aqueous solutions. (M.C.G.)

37421 DETERMINATION OF THE MOBILITY AND YIELD OF CHARGED PARTICLES CREATED BY THE PULSE RADIOLYSIS OF CRYSTALLINE ICE. Sharanin, Yu. I.; Shubin, V. N.; Dolin, P. I. (Inst. of Electrochemistry, Moscow). Dokl. Akad. Nauk SSSR; 195: 896-7(1 Dec 1970). (In Russian).

The pulse irradiation of ice crystals was studied in order to ascertain whether the mobility of negative carriers in the solid phase is much lower than in the liquid in which polarons are formed. The experiments were carried out with a 0.5-cm-thick ice layer formed in a cylindrical Teflon container between two titanium cathodes. The ice was exposed to pulsed bremsstrahlung from an accelerator at dose rates ranging from 0.025 to 0.25 rad. Dosimetric calculations based on the data revealed that the yield of charged particles was $Ge_+ = Ge_- = 0.8 \pm 0.15$ ion/100 eV. This agrees with an earlier study based on optical measurements. The ratio of the mobilities of the positive and negative charges was $U_+/U_- = 5$; the mobility of the individual carriers was $U_+ = 8.3 \times 10^{-2}$ and $U_- = 1.7 \times 10^{-2}$ cm^2/V sec. (TTT)

37422 EVIDENCE FOR THE FORMATION OF METHANE BY THE DISSOCIATION OF EXCITED BUTYL IONS IN THE RADIOLYSIS OF ETHYLENE. Gawlowski, J.; Niedzielski, J. (Univ., Warsaw). Radiochem. Radioanal. Lett.; 6: No. 6, 345-50 (31 May 1971).

Radiolysis of ethylene–hydrogen mixtures by γ radiation was investigated at an ethylene pressure of 3 torr and hydrogen pressures between 40 and 600 torr. The methane yield is considerably larger than that expected from the yield of vinyl ions. The results are interpreted in terms of proton transfer from H_3^+ ions to ethylene, followed by the reaction of ethyl ions with ethylene, yielding butyl ions. Excited butyl ions yield methane by dissociation. The decrease in $G(CH_4)$ with the increase in pressure is due to thermalization of ethyl ions, and stabilization of the butyl ions by collision. (auth)

37423 PRODUCTION OF HT DURING RADIOLYSIS OF THE C_6H_6/THO SYSTEM. Kroh, J.; Karolczak, S.; Burzynska, E. (Technical Univ., Lodz, Poland). Radiochem. Radioanal. Lett.; 6: No. 6, 351-8(31 May 1971).

The radioinduced formation of HT in a benzene solution of HTO was studied. The HT yield increased with the use of various electron scavengers such as N_2O, naphthalene, or oxygen. The radiation yield of primary radiolysis products (G_m^x) responsible for the formation of HT is $= 2.5 \times 10^{-4}$. These products are most probably excited $C_6H_6^+$ ions. The reactivity constant (α_{THO}) in benzene is 4.45 M^{-1}. (auth)

37424 UNSTABLE INTERMEDIATES. PART LXXXVIII. ALKALI-METAL INTERACTION WITH TRAPPED HYDROGEN ATOMS IN [γ-IRRADIATED] BARIUM SULPHATE. Bloom, M. B. D.; Eachus, R. S.; Symons, C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 6, 833-6(1971).

Barium sulphate doped with various alkali metal salts gave, on exposure to ^{60}Co γ rays at 77°K, two types of trapped hydrogen atoms, one of which had ESR spectra characterized by hyperfine coupling to the alkali metal cations. For example, the species NaH^+ had $g_{av} = 2.0013$, $a_{||}(^1H) = 513.2$ G, $a_{\perp}(^1H) = 510.7$ G, $a_{||}(^{23}Na) = 21.4$ G and $a_{\perp}(^{23}Na) = 15.1$ G. These results, together with data for other host crystals, are discussed in terms of the structure of the adducts and their stability. (auth) (UK)

XUM

37425 EFFECT OF CRYSTALLINE PHASE ON THERMAL RECOVERY OF THE PHOTOBLEACHABLE ELECTRON-EXCESS CENTER IN GAMMA-IRRADIATED SUCCINONITRILE. Campion, Alan; Williams, Ffrancon (Univ. of Tennessee, Knoxville). J. Chem. Phys.; 54: No. 10, 4510-12(15 May 1971).

The optical spectra of γ-irradiated succinonitrile crystals (monoclinic) before and after photobleaching are shown. Thermal recovery of this photobleachable optical absorption was observed to occur in succinonitrile-h_4 ($t_{½}$ = 75 min at 87°K) and succinonitrile-d_4 ($t_{½}$ = 25 min at 87°K). When liquid samples of succinonitrile were quenched to 77°K and γ irradiated, the same center was produced as in the monoclinic crystal. However, the optical absorption of these samples did not recover on storage for several days at 87°K after photobleaching. It was concluded that bcc crystals were produced in these experiments. It is therefore suggested that thermal recovery after photobleaching is entirely dependent on the spatial disposition of the fragments ($\cdot CH_2CH_2CN$ and CN^-) in the lattice. (M.C.G.)

37426 FACTORS AFFECTING THE LOW-DOSE GAMMA IRRADIATION OF HYDROCARBONS. Poxon, D. W.; Oldham, G. (Loughborough Univ. of Tech., Eng.). Radiat. Eff.; 8: No. 1-2, 43-7(Mar 1971).

The effect of differing conditions on the extent and nature of the damage produced in organic substances by γ-irradiation at low dose rates has been examined by a new chromatographic method which makes detection possible in a region where all other standard techniques fail. Use is made of the fact that certain surface-active dyes profoundly affect the shape of a chromatographic band in a manner related to the composition of the material undergoing chromatography. Taking length of outline per unit area as a measure of the shape of the band on paper impregnated with such dyes, a method of chromatography has been evolved, having a completely standardized development technique for all mixtures which does not require the separation of the components of the mixture. This outline/area index varies with the temperature according to the nature of the polar groups of the compounds present in the mixture under investigation and with the concentration of the individual components. It is thus possible to construct a three-dimensional diagram having as axes, temperature, concentration, and index. The diagram obtained is absolutely characteristic of the composition of a given mixture. (auth)

37427 RADIOLYSIS BEHAVIOR OF SOME ORGANOBORATE COMPOUNDS. Nencetti, G. F.; Tarli, R.; Zanelli, S. (Univ., Pisa, Italy). Ing. Nucl.; 11: 21-7(Jan-Feb 1970). (In Italian).

The radiolysis of some boro-organic aromatic compounds (pyrocatechol benzeneboronate, diphenyl benzeneboronate, benzeneboronic anhydride, and triphenyl borate) was studied in order to evaluate the possibility of their use for the regulation and control with soluble poisons of reactors cooled and moderated with organic fluids. Although the pyrolytic stability appears satisfactory, the radiolysis behavior does not make these compounds suitable for the purpose desired. From the results obtained it appears that the principal cause of the degradation of the compounds is the α radiation coming from the neutron capture reactions of boron. (tr-auth)

37428 RADICAL-ION FORMATION OF AZAAROMATIC COMPOUNDS BY γ-IRRADIATION AT LOW TEMPERATURE. David, C.; Janssen, P.; Geuskens, G. (Univ. Libre, Brussels). Spectrochim Acta, Part A; 27: 367-76(Mar 1971).

Radical cations are formed when pyridine, 4-methylpyridine, 2,6-dimethylpyridine, 2,2′-bipyridyl, phthalazine, 4-vinylpyridine, quinoline, isoquinoline, acridine, phenazine, 1-, 4- and 9-azaphenanthrene are irradiated with γ-rays at 77°K in s-butyl chloride while radical anions of the same azaaromatic compounds are formed in methyltetrahydrofuran glasses. The absorption spectra are reported and discussed. Cation formation is assigned to abstraction of an electron from the π-aromatic system in the last eight compounds. (auth) (UK)

37429 ELECTRON YIELDS AND THE EARLY STAGES OF RADIOLYSIS IN AQUEOUS SYSTEMS. Buxton, G. V.; Cattell, F. C. R.; Dainton, F. S. (Cookridge Hospital, Leeds, Eng.). J. Chem. Soc., D; 23-5(6 Jan 1971).

Pulse radiolysis of a 10 M OH^- solution between 300 and 77°K shows: that the maximum yield of solvated electrons is 5, 30% of which do not escape from the spurs; that this medium is rigid below 135°K; and that diffusion-controlled reactions in this medium obey the equation $\ln k = \ln A - E/R(T - 135)$, values of A lying in the range 10^{11} to 10^{12} M^{-1} S^{-1} and E from 6.4 to 7.4 kJ $mole^{-1}$ (auth) (UK)

37430 COMPARATIVE STUDY OF THE EFFECTS OF UV AND ELECTRON-BEAM IRRADIATION ON DIPHENYLAMINE BY ELECTRON SPIN RESONANCE TECHNIQUE. Tanei, Tadayoshi (Sekisui Chemical Co. Ltd., Osaka); Hatano, Hiroyuki. Bull. Inst. Chem. Res., Kyoto Univ.; 49: No. 1, 31-7(Jan 1971).

Intermediate radicals from photolysis and radiolysis of diphenylamine at the temperature of liquid nitrogen were investigated by electron spin resonance. ESR spectra corresponding to the diphenylamino and the diphenylamine cation radical could not be observed in the present experiment. Products from uv-irradiation of diphenylamine exhibited a single line spectrum with ΔH_{msl} of approximately 20 gauss, not showing any anisotropy. This single line spectrum was tentatively assigned to a phenyl-type radical, which was formed by the cleavage of a C–H bond. Electron-beam irradiated diphenylamine gave a triplet–triplet spectrum, which exhibited the anisotropy of hfs. This triplet–triplet spectrum can be identified as a cyclohexadienyl-type radical which was produced from the addition reaction of a hydrogen atom to the ortho or the para position in phenyl ring. (auth)

37431 COMPARATIVE ASPECT OF RADICAL SPECIES PRODUCED FROM SEVERAL BENZENE DERIVATIVES BY PHOTO AND IONIZING RADIATIONS. Hatano, Hiroyuki (Kyoto Univ.); Tanei, Tadayoshi. Bull. Inst. Chem. Res., Kyoto Univ.; 49: No. 1, 38-42(Jan 1971).

Free radicals produced from ultraviolet-, electron-beam-, and gamma-irradiated benzene derivatives were detected by an electron spin resonance method, and their structures are discussed. Distinguishable differences on the structures between both radicals produced by the photo and ionizing radiations were found in these experiments. Both phenyl and hexadienyl radicals were produced when irradiated with ionizing radiation, contrary to only phenyl radicals with ultraviolet irradiation. The results presented useful consideration on mechanisms of direct actions of radiation. (auth)

37432 ELECTRON SPIN RESONANCE STUDIES OF γ-RADIOLYSIS OF α-AMINOBUTYRIC ACID. Mach, K. (Inst. of Physical Chemistry, Prague). Collect. Czech. Chem. Commun.; 36: No. 3, 1279-90(Mar 1971).

Polycrystalline samples and single crystals of α-aminobutyric acid and D_3-α-aminobutyric acid were irradiated at 77°K, then either gradually heated up or photolyzed, and their electron spin resonance spectra were measured. Analysis of these spectra showed that at 77°K in addition to the radical-anion $CH_3CH_2CH(NH_3^+)\dot{C}OO^{2-}$ further alkyl radicals $\dot{C}H_2CH_2CH(NH_3^+)COO^-$ and $CH_3\dot{C}HCH(NH_3^+)COO^-$ were formed. The radical-anion disappeared during the photolysis at 77°K without giving rise to another paramagnetic particle. On heating the sample, this radical decomposed presumably to the unstable radical $CH_3CH_2\dot{C}HCOO^-$, which then, on further heating, gave rise to the stable radical $CH_3\dot{C}HCH(NH_3^+)COO^-$. The radical $(CH_3)_2\dot{C}CO^-$ was formed on the expenses of the latter radical at 100°C, but disappeared at 150°C, and a new radical was formed, which was not identified. The question of determination of products of oxidative effects of radiolysis is discussed in connection with the occurrence of the radical $\dot{C}H_2CH_2CH(NH_3^+)COO^-$. (auth)

37433 FORMATION OF ClO_4 AND ClO_3 RADICALS IN GAMMA-IRRADIATION OF FROZEN AQUEOUS SOLUTIONS OF POTASSIUM PERCHLORATE AND PERCHLORIC ACID AS DETERMINED BY EPR. Marov, I. N.; Simons, M. (Univ. of Leicester, Eng. Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Neorg. Khim.; 16: No. 5, 1193-8(May 1971). (In Russian).

Atomic hydrogen and OH radicals are formed during gamma-irradiation of aqueous solutions of $KClO_4$ at 77°K. Slow thawing of these solutions leads to the formation of a new radical, which was identified by electron paramagnetic resonance (EPR) as ClO_4. Irradiation of concentrated $HClO_4$ solutions at 77°C forms H and OH radicals, which disappear on cautious thawing. ClO_3 radicals develop thereupon, having a well-defined EPR spectrum. A comparison of the parameters of the spin-Hamiltonian series of isoelectron radicals was made, and mechanisms of their formation are discussed. (tr-auth)

37434 RADIOLYSIS OF AQUEOUS NITRATE SOLUTIONS. Faraggi, M. (Nuclear Research Center, Negev, Israel); Zehavi, D.; Anbar, M. Trans. Faraday Soc.; 67: No. 579, 701-10(Mar 1971).

The radiolysis of aqueous nitrate ion solutions was studied as a function of concentration in the presence of air, oxygen, and hydrogen. In dilute solutions, NO_3^- was reduced to NO_2 by hydrated electrons and H atoms. OH radicals oxidized the NO_2^- formed. In the presence of oxygen at relatively low concentrations of NO_3^-, NO_2 reacts with HO_2. Primary yields of e_{aq}^-, H, OH, and H_2O_2 were determined for the range of 10^{-3} to 10^{-1} M NO_3^-. $G_R = G_{e_{aq}^-} + G_H$ increased from 3.21 to 3.46, accompanied by a corresponding decrease of G_{H_2}. The observed yields of $G_{OH} = 2.62 \pm 0.03$ and of

$G_{H_2O_2}$ = 0.73 ± 0.02 were independent of NO_3^- concentration. For higher NO_3^- concentrations a linear increase of the total yield $G_R + 2G_{H_2}$ was observed. This may be interpreted due to the formation of NO_2^- and OH radicals by subexcitation electrons, which otherwise would form molecular hydrogen or hydrated electrons. Above 1 M nitrate decomposed by "direct action" to give nitrite. The yield of "molecular" hydrogen decreased with increasing nitrate concentration, whereas the yield of hydrogen peroxide remained constant with $G(H_2O_2) = 0.75 \pm 0.02$ over the whole concentration range up to 5 M. Oxygen 18-enriched nitrate ions in H_2O^{16} and H_2O^{18}, used to determine the origin of the hydrogen peroxide at high NO_3^- concentration, showed that the part of H_2O_2 which originates from the decomposition of nitrate ion by direct action is directly proportional to the fraction of energy absorbed by these ions. (auth) (UK)

37435 EFFECT OF TEMPERATURE ON THE EARLY STAGES OF RADIOLYSIS. PART I. PULSE RADIOLYSIS OF ALKALINE AQUEOUS SOLUTIONS BETWEEN 300 AND 77°K. Buxton, G. V.; Cattell, F. C. R.; Dainton, F. S. (Univ. of Leeds, Eng.). Trans. Faraday Soc.; 67: No. 579, 687-700(Mar 1971).

The wavelength λ_{max} for which absorption is a maximum in the spectrum of hydrated electrons in 10 M alkaline solution shows a monotonic blue shift from 680 nm at .00 K to 585 nm at 140°K, below which no further change occurs. $G(e_s^-)\epsilon$ (ϵ = molar extinction coefficient at λ_{max}) measured immediately after a 0.2 μs pulse of 3 MeV electrons increased by about 50% as T decreased from 300 to 220°K, then sharply decreased by about 40% of this maximum value as T fell from 220 to 140°K, thereafter remaining constant to 77°K. Added nitrite, nitrate, or chromate ions reduced $G(e_s^-)\epsilon$ at all temperatures in a manner suggesting a simple competition between solute and potential traps for mobile electrons. The decay of the electrons had a faster component, which became slower and more pronounced as T fell and accounted entirely for the increase of $G(e_s^-)\epsilon$ as T fell from 300 K to 220 K, when the order of this decay changed from first towards second. Spectral shape changes indicated that "red" electrons can be mobilized more easily than "blue" electrons, but that retrapping is less probable the lower the temperature. The first- and second-order rate constants for solute-free and solute-containing systems all fit the equation $\ln k = \text{constant} - (6.8 \pm 0.6\ \text{kJ})/R(T - 135)$. These and related data are interpreted in terms of a spur model and diffusion controlled processes with 135°K as the temperature below which these systems can be regarded as entirely rigid. (auth) (UK)

37436 YIELDS AND DECAY PROCESSES OF THE SOLVATED ELECTRON IN LIQUID ALCOHOLS AT LOW TEMPERATURE OBSERVED BY NANOSECOND PULSE RADIOLYSIS. Baxendale, J. H.; Wardman, P. (Univ. of Manchester, Eng.). J. Chem. Soc. D; No. 9, 429-30(5 May 1971).

Observations on e_s^- in alcohols are used to show that ca. one-third of the total electrons produced recombine before solvation, that in the reaction of e_s^- with alcohols neither diffusion nor dielectric relaxation are rate determining, and that the total yield of e_s^- in water may be as high as 5. (auth) (UK)

Radioisotope Production

Refer also to abstracts 38961, 38974, and 38975.

37437 (BNWL-CC-2664) PRODUCTION OF PURE ^{143}Pm BY PROTON IRRADIATION OF ^{144}Sm. McConnon, D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 7 Aug 1970. Contract AT(45-1)-1830. 11p. Dep. NTIS.

^{143}Pm of high radionuclidic purity was produced by proton irradiation of ^{144}Sm. The use of such ^{143}Pm in future human metabolism studies as a substitute for ^{147}Pm insures that doses to volunteer test subjects will be reduced by about 25% compared to the doses received in previous studies in which ^{143}Pm containing small amounts of ^{144}Pm was used. (auth)

37438 (CEA-R-4101) ELECTRODEPOSITION OF YTTRIUM AND THE RARE EARTHS. Gusmini, Simone; Terraillon, Monique (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jan 1971. 20p. (In French). Dep. NTIS (U. S. Sales Only).

Much work has been done on the electrodeposition of rare earths by cathodic or anodic deposition in aqueous acid or organic media. After various tests, it was decided that the cathodic deposition of Ce, Y, Eu, Tb, La, Pr, Er, and Nd in organic aqueous systems presented the fewest difficulties. A comprehensive study of the different parameters governing the deposition is presented: electrolysis pH and time, current density, voltage, electrode surface and distance. As an application, thin ^{147}Pm radiation sources and sources for mass spectrometry were prepared. (France)

37439 (EUR-4612, pp 61-8) SOME ASPECTS OF THE PRODUCTION OF TRANSURANIUM ELEMENTS IN FRANCE. Chesne, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Development of the production program of transuranium elements during the past decade is reviewed. The chemical processes being used or studied and the production facilities set up are mentioned and discussed. (auth)

37440 (EUR-4612, pp 69-84) ACTINIDE PROJECT OF THE GESELLSCHAFT FUER KERNFORSCHUNG mbH, KARLSRUHE. Hoehlein, G.; Gasteiger, R. (Kernforschungszentrum, Karlsruhe (West Germany)). (In German).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Work done so far in the Federal Republic on production of transuranium elements is surveyed. On the basis of experience gathered, a program is being launched for the production and application of actinides. The aim of the project is to produce the quantities of ^{238}Pu, ^{244}Cm, and ^{252}Cf needed in order to prepare the way for industrial use, and to establish the technical requirements in conjunction with the industry. (auth)

37441 (EUR-4612, pp 85-98) REMARKS ON THE PRODUCTION ASPECTS OF THE TRANSPLUTONIUM RESEARCH PROGRAM IN THE UNITED STATES. Penneman, R. A. (Los Alamos Scientific Lab., N. Mex.); Ferguson, D. E. (Oak Ridge National Lab., Tenn.).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Production of transplutonium elements is reviewed. Nuclear reactions, facilities requirements, and yields of ^{241}Am, ^{252}Cf, and other heavy elements are discussed. (M.C.G.)

37442 SEPARATION OF CARRIER FREE ^{54}Mn AND ^{59}Fe USING REVERSED PHASE PARTITION CHROMATOGRAPHY. El-Garhy, M.; Aly, H. F.; El-Reefy, S. (Atomic Energy Establishment, Cairo). Isotopenpraxis; 6: 478-80(Dec 1970).

The system Aliquat 336–Celite 360–HCl was used in reversed-phase partition chromatography to produce carrier-free ^{54}Mn and ^{59}Fe. Elution characteristics were determined for Co, Fe, and Mn. (M.C.G.)

37443 PROCESS FOR THE SEPARATION OF CARRIER-FREE ^{85}Sr. Mikheev, N. B.; Savel'ev, G. I.; Popovich, V. B. (to Biophysics at the Dept. of Public Health). Russian Patent 223,217. 25 Apr 1969. Filed 10 May 1966. (In Russian).

A process is described for the separation of carrier-free ^{85}Sr from an irradiated target of metallic rubidium. In order to accelerate the process and to increase the purity of the finished product, the target was placed in an inert gas atmosphere and dissolved in methyl alcohol. The solution was passed through a column of activated carbon, and the ^{85}Sr was then washed with acid. (E.J.H.)

37444 ELECTRODEPOSITION OF CARRIER-FREE TANTALUM ISOTOPES. Molnar, J.; Molnar, Iren (Central Inst. for Physical Studies, Budapest). Acta Chim. Acad. Sci. Hung.; 67: No. 1, 15-22(1971). (In Russian).

The electrodeposition of carrier-free tantalum isotopes was investigated. The dependence of deposition on the composition of electrolytes, current density, and other parameters was measured. The experiments were performed in a special capillary cell. Electrolysis is useful for the preparation of radiation sources of carrier-free tantalum isotopes suitable for beta-spectroscopic measurements. (auth)

37445 ELECTROLYSIS OF CARRIER-FREE TUNGSTEN AND RHENIUM ISOTOPES. Molnar, J.; Molnar, Iren (Central Inst. for Physical Studies, Budapest). Acta Chim. Acad. Sci. Hung.; 67: No. 1, 23-31(1971). (In Russian).

The electrolysis of carrier-free tungsten and rhenium isotopes and the dependence of electrolytic deposition on the composition of the ground electrolyte and on other parameters were investigated. On the basis of experimental results, methods for the preparation of radiation sources of neutron-deficient tungsten and rhenium isotopes were developed for purposes of nuclear spectrometry. (auth)

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37446 ISOLATION OF RADIOACTIVE ^{48}V AND ^{49}V FROM A TITANIUM TARGET IRRADIATED IN A CYCLOTRON. Vinogradova, V. G.; Sevast'yanov, Yu. G.; Iofa, B. Z.; Nesmeyanov, A. N. (Moscow State Univ.). Izotopy SSSR; No. 17, 35-7(1970). (In Russian).

A new simple and efficient method is suggested for separating vanadium-48 and vanadium-49 from a Ti target. (tr-INIS)

37447 PRODUCTION OF CARRIER-FREE SCANDIUM RADIOISOTOPES FROM A NEUTRON-IRRADIATED POTASSIUM TITANIUM OXALATE TARGET. Aly, Hisham F.; El-Haggan, Mohammed A. (Atomic Energy Establishment, Cairo). Mikrochim. Acta; No. 1, 4-8(1971).

Extraction of Sc and Ca radioactivities with 1% HDEHP in benzene from HNO_3 solution was investigated. The effect of potassium titanium oxalate concentration on the extraction from 1.5 M HNO_3 was studied. Two procedures based on batch solvent extraction and extraction chromatography were developed for separation and production of radioscandium from a neutron-irradiated potassium titanium oxalate target. The radiochemical purity of the separated scandium radioactivities was more than 98%. (auth)

Recoil Production and Reactions

Refer also to abstracts 38540 and 38541.

37448 EFFECT OF CATIONIC COMPONENTS ON THERMAL ANNEALING OF BROMINE RECOILS IN ALKALINE EARTH BROMATES. Shiokawa, T.; Sasaki, T.; Takahashi, S. (Tohoku Univ., Sendai). Radiochem. Radioanal. Lett.; 6: No. 6, 327-31(31 May 1971).

The thermal annealing rate of bromine recoils by nuclear isomeric transition increases in order of the atomic number of the counterpart cation in the bromate. The cationic effect was interpreted in terms of the electrostatic character of alkaline earth ions in the same manner as in alkali bromates. (auth)

37449 REACTION MODELS FOR THE ANNEALING OF RECOIL ATOMS IN SOLIDS. Milenkovic, S. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia); Bingulac, S.; Veljkovic, S. J. Inorg. Nucl. Chem.; 33: 1187-93(Apr 1971).

The annealing reactions of the radioactive chromium, ^{51}Cr, in K_2CrO_4, either pure or doped by alkali halides, were studied. A systematic investigation of various reaction models was carried out using a digital computer. The program allowed for the presence of metastable intermediates under steady state conditions, as well as of dual reaction paths. Calculations were made for data obtained at two annealing temperatures. Reaction rate constants and activation energies served as a means of discrimination between the various models. The explanation of the most satisfactory models was based on a complex reaction mechanism dependent on chemical and structural inhomogenities in the target. (auth) (UK)

37450 INERT MODERATORS IN HOT ATOM CHEMISTRY. Westhead, Catherine; Urch, D. S. (Queen Mary Coll., London). J. Chem. Soc., D; No. 8, 403-4(21 Apr 1971).

Product ratios change in different ways when different "inert" moderators are used in hot-atom experiments; thus, changes in product ratios can no longer be used to determine relative energies of the hot atoms initiating particular reactions. (auth) (UK)

37451 SZILARD–CHALMERS EFFECT IN CdS AND CdTe. Kikuchi, Chihiro (Kyoto Univ. Univ. of Michigan, Ann Arbor). Bull. Inst. Chem. Res., Kyoto Univ.; 49: No. 1, 14-30(Jan 1971).

The neutron damage effect in crystalline CdS and CdTe was investigated by measuring photoluminescence and conductivity change. The photoluminescence measurements for CdS show the ratio of the Cd concentration resulting from thermal and fast neutron irradiation to be about 28, different from the result by conducting measurements, about 40. Some theoretical aspects of these results are also given. For CdTe, two types of the crystals were studied: n-type and p-type CdTe. Changes of carrier concentration in CdTe crystal were measured before and after thermal neutron irradiation. In the case of n-type CdTe, it was concluded that thermal neutrons produce predominantly Cd defects in the crystal and no evidence for the Te vacancies was observed. Although measurements on p-type CdTe indicate decreases of the hole concentration by thermal neutron irradiation, the value obtained is still large in comparison to the intrinsic value of the hole concentration. (auth)

Radiochemistry

Refer also to abstracts 37315, 37448, and 37707.

Separation Processes

Refer also to abstracts 37404, 37439, 37446, 37447, 39130, 39134, and 39182.

37452 (A/CONF.49/P-64) RECOVERY OF LMFBR FUELS: DEVELOPMENT OF TECHNIQUES. Ferguson, D. E. (Oak Ridge National Lab., Tenn.); Cooley, C. R. (Hanford Engineering Development Lab., Richland, Wash.); Sheldon, E. B. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant); Webster, D. S. (Argonne National Lab., Ill.). Sep 1971. 20p. (CONF-710901-11). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Problems associated with the processing of LMFBR fuels are discussed. Methods using basic Purex technology are being developed. The deactivation and removal of sodium, cooling of the spent fuel elements, two alternative head-end processes, and dissolution and feed preparation for the high-plutonium-content, high-burnup fuel are being studied. Solvent extraction flow sheets to accommodate the higher plutonium and fission-product concentrations were developed and are being tested. The control of radioactive effluents is discussed. (M.C.G.)

37453 (A/CONF.49/P-65) EXISTING AND PROJECTED PLANTS AND PROCESSES FOR THERMAL REACTOR FUEL RECOVERY: EXPERIENCE AND PLANS. Sinclair, E. E. (Atomic Energy Commission, Washington, D. C.); Larson, H. J. (Allied-Gulf Nuclear Services, Florham Park, N. J.); Lewis, W. H. (Nuclear Fuel Services, Inc., Wheaton, Md.); Moody, L. S. (General Electric Co., San Jose, Calif.); Osborn, K. R. (Allied Chemical Nuclear Products, Inc., Florham Park, N. J.); Rathvon, H. C. (Atlantic Richfield Co., New York). Sep 1970. 12p. (CONF-710901-12). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The status of commercial nuclear fuel reprocessing plants in the United States is summarized. The West Valley NFS Plant has successfully operated since April 1966. The process employs a shear-leach head end, followed by Purex decontamination and separation of uranium and plutonium, and a final ion-exchange cycle for plutonium. Construction of the Midwest Fuel Recovery Plant was completed. The design is based on the Aquafluor process: mechanical disassembly, Purex cycle, aninon exchange, and fluidized-bed fluorination for final uranium decontamination. The Barnwell Fuel Processing Plant is under construction with commercial operation expected to begin in 1974. A mechanical chop-leach head end is coupled with basic Purex technology. The Atlantic Richfield Leeds plant is planned for operation by July 1976 using a chop-leach head end and Purex technology. Recent developments in siting and waste management criteria are discussed. (M.C.G.)

37454 (BARC–523) SYNTHESES OF PHYLLITIC MINERALS: THEIR UTILISATION IN RADIOACTIVE WASTE TREATMENT. PART IV. FROM MIXED GELS OF SILICA AND ALUMINA IN PRESENCE OF CALCIUM ACETATE AND SODIUM ACETATE. Brat, Satya; Balu, K. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 18p. Dep. NTIS (U. S. Sales Only).

Silica and alumina gels were mixed in different molecular ratios and boiled with calcium acetate at 100°C and ambient pressure for 45 days. The products were found to be crystalline and of the montmorillonite group of clay minerals. Mineralogical properties of the products were evaluated and the products were studied for their selectivity coefficients. Using Cs^+, the sorption capacities of the products were determined. (auth)

37455 (BARC–534) TRANSFORMATION OF NATURALLY OCCURRING INTERSTRATIFIED VERMICULITES OF INDIAN ORIGIN TO PURE VERMICULITES WITH HIGHER CATION EXCHANGE CAPACITIES AND IMPROVING THEIR SUITABILITY FOR DECONTAMINATION OF RADIOACTIVE WASTE. Brat, Satya; Balu, K.; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay (India)). 1971. Contract 657/RB. 109p. Dep. NTIS (U. S. Sales Only).

Transformation of interstratified vermiculite of India to pure vermiculite for use in decontamination of radioactive wastes is described. Studies on the physical and chemical characteristics of six different samples of vermiculite and their mineralogical evaluations are reported. By two different chemical treatment methods, these minerals were transformed. The methods used were: treatment with sodium cobaltinitrite and treatment with 3N sodium chloride + 5% hydrogen peroxide. The transformed products were evaluated by sorption studies using 0.1N CsCl +

^{134}Cs and 0.1N $SeCl_2$ + $^{85+89}Sr$. Products transformed by sodium chloride and hydrogen peroxide treatment were found to be better transformed, with higher capacity for removal of Cs^+ and Sr^{2+}. (auth)

37456 (CONF-710416–, Paper 17) INTRODUCTION: FUTURE REQUIREMENTS FOR LICENSED RADIOCHEMICAL PLANT OPERATORS. Brooksbank, R. E. (Oak Ridge National Lab., Tenn.). 6p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

37457 (CONF-710416–, Paper 18) OPERATOR TRAINING AND LICENSING ACTIVITIES AT THE NUCLEAR FUEL SERVICES PLANT. Knight, Bruce E. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 12p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

37458 (IAEA-R-341-F) THE PURIFICATION OF LOW-ACTIVITY WASTES AND THE SEPARATION OF FISSION PRODUCTS IN A SEMI-AUTOMATIC CHROMATOGRAPHIC FACILITY. Final Report, October 1, 1965-February 28, 1969. Chmutov, K. V. (International Atomic Energy Agency, Vienna (Austria)). Apr 1970. vp. (In Russian). NTIS (U. S. Sales Only).

Studies were carried out to provide guidance in the selection of adsorbents and the sorption conditions required to ensure purification of low-activity wastes. Aluminum oxide can be used for the separation of fission products from low-active liquid wastes with pH 4, containing mono- and divalent cations in concentrations from 0 to 2N. Zr and Nb can be removed by increasing the pH above 10. Carboxylic resin SG-1 can be used for separation of uranium from low-activity liquid effluents containing high quantities of stable salts in the interval of pH 2 to 3. Chromatographic separation of ^{147}Pm from the mixture of fission products in low-activity liquid wastes is effective when ethylendiaminetetraacetic acid (EDTA) and diethylentriaminepentaacetic acid (DTPA) are used. (INIS)

37459 (IN-1471) ZIRCONIUM FUEL REPROCESSING CAMPAIGN OF 1970. Henry, R. N.; Offutt, G. F. (Idaho Nuclear Corp., Idaho Falls). Apr 1971. Contract AT(10-1)-1230. 25p. Dep. NTIS.

Zirconium–uranium alloyed fuels were again processed at the Idaho Chemical Processing Plant during 1970. Improvements over previous campaigns in processing rates, waste generation rates, and uranium recovery were realized. A head-end centrifuge was used for the first time at ICPP to clarify feed to the extraction system, and this unit contributed significantly to improved performance of the system. (auth)

37460 (KFK-1346) DECONTAMINATION OPERATIONS DEPARTMENT ANNUAL REPORT, 1969. Krause, H. (Kernforschungszentrum, Karlsruhe (West Germany). Jan 1971. 105p. (In German). Dep. NTIS (U. S. Sales Only).

Research progress is reported on the fixation of radioactive materials in bitumen, cement, glass, and ceramic materials. A pilot plant was built for demonstration on a larger scale of the decomposition of nitric acid and nitrates by means of formic acid. (D.H.M.)

37461 (KURRI-TR-80) DESIGN OF RADIOACTIVE WASTES TREATMENT FACILITIES. Tsutsui, Tenson; Shimoura, Kazukuni (Kyoto Univ. (Japan). Research Reactor Inst.). 5 Oct 1970. 74p. (In Japanese). Dep. NTIS (U. S. Sales Only).

In order to dispose of radioactive liquid and solid waste, a treatment plant was installed in the Kyoto University Research Reactor Institute in 1964. The radioactive liquid waste treatment plant consists of three main processes such as evaporation, chemical precipitation-filtration, and ion exchange. Some technical and engineering improvements were added to this treatment plant during usual operation and maintenance. A freezing and thawing facility for sludge handling was installed in 1965 and an addition in 1967. The designs of the facilities and equipment such as storage tank, evaporator, mist separator, flocculator, filter, ion exchanger, freezing tank, and bailer, are described. (auth)

37462 (KURRI-TR-81) MANAGEMENT OF RADIOACTIVE LIQUID AND SOLID WASTES. Tsutsui, T.; Kanagawa, A.; Koyanaka, Y.; Shimoura, K.; Kimura, S.; Yokochi, A.; Nishimaki, K.; Kitagawa, I.; Oono, K.; Kan, I. (Kyoto Univ. (Japan). Research Reactor Inst.). 7 Oct 1970. 14p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The radioactive waste treatment plant of the Research Reactor Institute, Kyoto University has operated since June 1964. In 1968, 2000 m^3 of low and very-low level liquid wastes (10^{-5} to 10^{-8} μCi/ml) and 1000 Kg solid wastes were produced as a result of the reactor operation and research works. The wastes gradually increased in quantity and total activity, but the activity levels of low and very-low level liquid wastes were almost constant. The management of radioactive liquid and solid wastes at the Research Reactor Institute, Kyoto University during the past 5 years, from June of 1964 to March of 1969, is reviewed. (auth)

37463 (KURRI-TR-83) STUDY ON REMOVAL OF RADIOACTIVE Cs BY VERMICULITE COLUMN. Tsutsui, Tenson; Kimura, Syojiro (Kyoto Univ. (Japan). Research Reactor Inst.). 1 Nov 1970. 10p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Ion-exchange properties of vermiculite for removal of Cs^+ ions from radioactive waste water were investigated. It has a 0.240 meq/g ion exchange capacity to Cs^+ ions and a 0.150 meq/g breakthrough ion exchange capacity at flow rate SV-4. K^+ and NH_4^+ ions influence Cs^+ ion exchange on vermiculite. In particular, the ion exchange capacity to Cs^+ ion was lower when NH_4^+ ions changed place with Na^+ ions in the exchange position of vermiculite. (auth)

37464 (RFP-1642) PLUTONIUM AND AMERICIUM RECOVERY FROM A CHLORIDE-SALT MATRIX. Kudera, Donald E.; Guyer, Raymond H. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 4 Jun 1971. Contract AT(29-1)-1106. 6p. Dep. NTIS.

A cation-anion exchange process was developed for the recovery of americium and plutonium from alkaline, chloride-salt residues. The residues are generated by a molten-salt process used for the extraction of americium from plutonium metal. The salts are dissolved in dilute nitric acid and the chloride is separated from the plutonium and americium by cation exchange. The americium is separated from the plutonium by anion exchange. Kilogram amounts of chloride salts were successfully processed by this cation-anion procedure. (auth)

37465 ANION EXCHANGE OF METAL IONS IN NITRIC ACID, AQUEOUS-ORGANIC SOLVENT SYSTEMS. I. METHANOL. Walter, C. W.; Korkisch, J. (Univ., Vienna). Mikrochim. Acta; No. 1, 81-95(1971). (In German).

A study was made of the anion exchange properties of 23 elements in nitric acid–methanol solvents. In these systems the batch-distribution coefficients of the following were determined with employment of the strongly basic anion exchanger Dowex 1-X 8: uranium(VI), thorium(IV), cerium(III), ytterbium(III), scandium(III), iron(III), aluminum(III), gallium(III), indium(III), bismuth(III), zinc(II), cadmium(II), copper(II), silver(I), nickel(II), cobalt(II), manganese(II), rhenium(VII), and technetium(VII). At a total acidity of 0.6 N nitric acid, all of the distribution coefficients were determined at 6 different concentrations of the organic solvent (0, 20, 40, 60, 80, and 90 vol %). Likewise all distribution coefficients were measured in mixtures that contained 90 vol % methanol, at 5 different total normalities of nitric acid (0.15, 0.30, 0.60, 0.90, and 1.20 N). The adsorption behavior of the metals was discussed on the basis of these measurements; the conditions for the separation of different ion groups were stated. A number of the separation experiments were discussed in classified fashion and fixed graphically in the corresponding elution curves. (auth)

37466 ANION EXCHANGE OF METAL IONS IN NITRIC ACID, AQUEOUS-ORGANIC SOLVENT SYSTEMS. II. ETHANOL, ISOPROPANOL, AND METHYL GLYCOL. Walter, C. W.; Korkisch, J. (Univ., Vienna). Mikrochim. Acta; No. 1, 137-57(1971). (In German).

The anion exchange characteristics of 23 elements in organic solvents containing nitric acid were studied. In these systems the batch-distribution coefficients of the following metal ions were investigated with the employment of the strongly basic anion exchanger Dowex 1-X 8: uranium(VI), thorium(IV), cerium(III), ytterbium(III), scandium(III), yttrium(III), chromium(III), molybdenum(VI), vanadium(V), iron(III), aluminum(III), gallium(III), indium(III), bismuth(III), zinc(II), cadmium(II), copper(II), silver(I), nickel(II), cobalt(II), manganese(II), rhenium(VII), and technetium(VII). Ethanol, isopropanol, and methyl glycol were introduced as organic solvents. At a total acidity of 0.6 N nitric acid, all distribution coefficients were determined at 6 different concentrations of the organic solvent (0, 20, 40, 60, 80, and 90 vol %). Likewise, all distribution coefficients were measured in mixtures, which contain 90 vol % of the organic solvent, at 5 different total normalities of nitric acid (0.15, 0.30, 0.60, 0.90, and 1.20 N). The adsorption behavior of the metals is discussed on the basis of these measurements and the conditions for the separation of various groups of ions are given. A number of the separation

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trials conducted by the authors are discussed in orderly fashion and graphically fixed in the corresponding elution curves. (auth)

37467 ANION EXCHANGE OF METAL IONS IN NITRIC ACID AQUEOUS-ORGANIC SOLVENT SYSTEMS. III. TETRAHYDROFURAN AND ACETONE. Walter, C. W.; Korkisch, J. (Univ., Vienna). Mikrochim. Acta; No. 1, 158-72 (1971). (In German).

The anion exchange properties of 23 elements in organic solvents containing nitric acid are dealt with in the present work. The batch-distribution coefficients of the following metal ions were determined with employment of the strongly basic anion exchanger Dowex 1-X 8: uranium(VI), thorium(IV), cerium(III), ytterbium(III), scandium(III), yttrium(III), chromium(III), molybdenum(VI), vanadium(V), iron(III), aluminum(III), gallium(III), indium(III), bismuth(III), zinc(II), cadmium(II), copper(II), silver(I), nickel(II), cobalt(II), manganese(II), rhenium(VII), and technetium(VII). Tetrahydrofuran and acetone were introduced as organic solvents. All distribution coefficients were determined at 6 different concentrations of the organic solvent (0, 20, 40, 60, 80, and 90 vol %), at a total acidity of 0.6 N nitric acid. Likewise in mixtures which contained 90 vol % of the organic solvent, all distribution coefficients were measured at 5 different total normalities of nitric acid (0.15, 0.30, 0.60, 0.90, and 1.20 N). The adsorption behavior of the metals was discussed on the basis of these measurements and the conditions for the separations of various ion groups are stated. A number of the separation trials conducted by the authors are discussed in orderly fashion in accord with the solvents and the ion groups and fixed graphically into the corresponding elution curves. (auth)

37468 ANION EXCHANGE OF METAL IONS IN NITRIC ACID AQUEOUS-ORGANIC SOLVENT SYSTEMS. IV. ACETIC ACID AND DIMETHYL SULFOXIDE. Walter, C. W.; Korkisch, J. (Univ., Vienna). Mikrochim. Acta; No. 1, 181-93(1971). (In German).

The anion exchange characteristics of 23 elements in organic solvents containing nitric acid were studied. In these systems the batch-distribution coefficients of the following metal ions were investigated with employment of the strongly basic anion exchanger Dowex 1-X 8: uranium(VI), thorium(IV), cerium(III), ytterbium(III), scandium(III), yttrium(III), chromium(III), molybdenum(VI), vanadium(V), iron(III), aluminum(III), gallium(III), indium(III), bismuth(III), zinc(II), cadmium(II), copper(II), silver(I), nickel(II), cobalt(II), manganese(II), rhenium(VII), and technetium(VII). Glacial acetic acid and dimethylsulfoxide were introduced as organic solvents. All distribution coefficients were determined at a total acidity of 0.6 N nitric acid and at 6 different concentrations of the organic solvent (0, 20, 40, 60, 80, and 90 vol %). Likewise in mixtures, which contained 90 vol % of the organic solvent, all distribution coefficients were measured at 5 different total normalities of nitric acid (0.15, 0.30, 0.60, 0.90, and 1.20 N). The adsorption behavior of the metals was discussed in ordered fashion according to solvents and ion groups and fixed in the corresponding elution curves. Special weight was placed on the relations in the first little studied solvent DMSO, a medium in which it was found that there exists a very good separation possibility of rhenium and technetium from practically all other metal ions. (auth)

37469 ANION EXCHANGE OF METAL IONS IN NITRIC ACID AQUEOUS-ORGANIC SOLVENT SYSTEMS. V. THEORETICAL IDEAS. Walter, C. W.; Korkisch, J. (Univ., Vienna). Mikrochim. Acta; No. 1, 194-204(1971). (In German).

A survey of the previously published theoretical ideas and treatment of the anion exchange behavior of metals shows that the adsorption on the exchanger reaches a maximum when the metal for the most part is present as neutral complex, i.e., a maximal molarity of the neutral complex in the solution yields a maximum value of the distribution relation between the exchanger and the solution. (auth)

37470 WASH TREATMENT TO RESTORE THE DEGRADED D2EHPA-TBP USED IN FISSION PRODUCT EXTRACTION. Schulz, Wallace W.; Beard, Samuel J. (to United States Atomic Energy Commission). U. S. Patent 3,574,532. 13 Apr 1971. Filed 20 Mar 1969.

A process is disclosed for restoring the cerium(IV) extraction capacity of a chemically and/or radiolytically degraded solvent consisting of bis(2-ethylhexyl) phosphate and tributyl phosphate in a hydrocarbon diluent. The degraded solvent is treated with an aqueous solution of potassium permanganate and a mineral acid, preferably nitric acid. (Offic. Gaz.)

37471 Zr EXTRACTION BY TBP FROM AQUEOUS SOLUTIONS OF HNO_3 AND $HClO_4$. Solovkin, A. S. Zh. Neorg. Khim.; 16: No. 3, 865-6(Mar 1971). (In Russian).

A mathematical expression that describes the extraction of Zr by TBP from HNO_3–$HClO_4$ mixtures is given. Concentrations, activity coefficients, and solvent numbers were used in this equation over the range of acid compositions ranging from pure HNO_3 (6 M) to a mixture of 2M HNO_3–4 M $HClO_4$. The maximum in the distribution coefficient obtained by calculation agrees satisfactorily with that obtained from experimental data. (K.S.W.)

37472 EXPERIENCE OF PROCESSING RADIOACTIVE WASTES FROM LOW LEVEL IRRADIATIONS. Gagliardi, S.; Musy, D.; Rossi, M. Ing. Nucl.; 11: 11-19(Jan-Feb 1970). (In Italian).

An experimental plant for fixation in concrete of radioactive wastes is described. The course of operations and some economic valuations are also described. (auth)

37473 REPROCESSING IN SWITZERLAND. von Gunten, H. R. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland. Univ., Bern). Neue Tech., B; 12: 134 (Aug 1970).

The production of fuel to be processed is given for 1970 through 1979. Laboratory-scale and pilot-plant experiments were carried out to explore a head-end reprocessing system for high-temperature carbide–graphite fuels. (M.C.G.)

37474 LEACH TESTING OF IMMOBILIZED RADIOACTIVE WASTE SOLIDS. A PROPOSAL FOR A STANDARD METHOD. Hespe, E. D. (International Atomic Energy Agency, Vienna). At. Energy Rev.; 9: No. 1, 195-207(Apr 1971).

A treatment preliminary to the disposal of radioactive waste is its solidification and incorporation into a stable medium from which the radioactive components cannot readily be leached by waters that may come in contact with the waste after disposal. In order to test the quality of any solidified form of waste and to intercompare various products from different processes or different laboratories it is desirable to have a standard method of measuring the leach rate by water of the radioactive components in the solid waste. Two leach rate tests are presented that were the result of recommendations by a panel of experts convened by the International Atomic Energy Agency in August 1969. One method is for intercomparison purposes and the other to approximate the behavior of an immobilized solid under the conditions of the storage environment. The details of the methods include specimen preparation, leachant containers, leachant specifications, experimental conditions, and reporting of results. Extrapolation of test results to a disposal program is discussed. (auth)

37475 SEPARATION OF MICROGRAM QUANTITIES OF PALLADIUM AND PLATINUM AND THEIR ISOLATION FROM RUTHENIUM, RHODIUM, AND IRIDIUM. Kuznetsov, V. I.; Marugin, V. A. Ind. Lab. (USSR) (Engl. Transl.); 36: No. 11, 1675-6(Nov 1970).

Translated from Zavod. Lab.; 36: No. 11, 1318-20(Nov 1970).

A method is given for separation of the ternary mixtures palladium–platinum–ruthenium, palladium–platinum–rhodium, and palladium–platinum–iridium. Palladium is isolated in the form of the α-benzyldioximate. Platinum is precipitated from the filtrate using ammonium thiocyanate. Ruthenium, rhodium, and iridium pass into the filtrates, from which they are separated by the same organic coprecipitants after further heating. These elements precipitate practically quantitatively at dilutions between $1:10^7$ and $1:10^9$. The behavior of osmium is not considered, since OsO_4 readily volatilizes even from very dilute solutions. (auth)

37476 PAPER CHROMATOGRAPHY OF RARE EARTH ELEMENTS WITH THE DEVELOPER CONTAINING OXINE AND CHLOROFORM. Nagai, Hideo; Utsunomiya, Akira (Kumamoto Univ., Japan). Jap. Anal.; 20: 457-60(Apr 1971). (In Japanese).

The separation of rare earth elements using developers containing chloroform was studied. One hundred ml of chloroform, 150 ml of methyl carbitol, and 50 ml of 0.2M acetic acid–0.2M sodium acetate buffer (pH = ca. 4) were shaken well and to the separated lower layer was added 7.5g of oxine. The developer thus prepared was used throughout this study. A mixture of La, Ce, Nd, Sm, Eu, and Tb was separated by one development. There was considerable evidence to support the migration of cations in the form of positively charged complexes coordinated with one or two oxine molecules. (auth)

37477 DIFFICULTIES ENCOUNTERED IN THE EXTRACTION OF URANIUM FROM VOSGIAN SCHISTS. Wey, Raymond; Saehr, Daniel; Goepfert, Serge (Univ., Strasbourg). pp 559-65 of Comptes Rendus du 92e Congres National des Societes Savantes. Tome 2. Paris; Bibliotheque Nationale (1970). (In French).

From ninety-second national congress of the Learned Societies; Strasbourg, France (31 Mar 1967). See CONF-670342–(Vol. 2).

The uranium content of the black schists of Saint Hippolyte (upper Rhine) is so low that only continuous extraction using Na_2CO_3 solutions is financially viable. The rate of extraction is a function of several parameters: pH of solutions, carbonate anion concentration, temperature, and extraction time. Considerable time elapses before equilibrium conditions are reached, and under the most favorable conditions one-third of the uranium escapes extraction. A process of repeated extraction and desiccation led to a significant improvement in yield. When the decahydrate crystallizes the schist grains taken up by the solution burst thus exposing fresh surfaces to the solvent. (auth) (France)

37478 USE OF TRI-n-ALKYLAMINE AND -ARSINE OXIDE IN REVERSED-PHASE EXTRACTION CHROMATOGRAPHY. Leene, H. R.; De Vries, G.; Brinkman, U. A. Th. (Free Reformed Univ., Amsterdam). J. Chromatogr.; 57: No. 1, 173-80 (22 Apr 1971).

Reversed-phase extraction chromatography on silica gel layers impregnated with trioctylarsine oxide or Alamine 336-S oxide is described. R_F values are given for Ca, Ba, Zn, Cd, Hg, Be, Sc, Ce, Yb, U, Th, Al, Ga, In, Fe, Re, Ti, Zr, Hf, Sn, Pb, Cu, Co, Ni, Mn, Mo, Ag, Pt, Pd, Sb, and Bi. (M.C.G.)

37479 DRY-CHEMICAL REPROCESSING OF SPENT FUEL. Burk, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 14: No. 2, 33-9(Feb 1971). (In German).

Starting from the causes leading to elaboration of nonaqueous reprocessing techniques, some well-known processes are described. Estimates of technological status of development of the techniques and their appropriateness for requirements of fuel cycles indicate that only the fluoride volatilization technique is in the running for technical use in the near future. The difficulty of obtaining evident economic data for nonaqueous reprocessing is pointed out. (auth)

37480 ION EXCHANGE OF SOME METAL-DIETHYLENETRIAMINE N,N,N',N'',N''-PENTAACETIC ACID. Katayama, Masaaki (Asahi Glass Co., Ltd., Amagasaki, Japan); Masuda, Yoshitaka; Tarutani, Toshikazu; Misumi, Seizo. Jap. Anal.; 20: No. 4, 451-6(Apr 1971). (In Japanese).

When the metal–DTPA complex solution is passed through the cation exchange resin at constant pH, the complex anion is not adsorbed on the resin, and only the dissociated metal cation is exchanged on it. The relationship between the exchanged adsorption volume of the metal ions and pH was investigated. The adsorption of some metal–DTPA complexes [M = La(III), Y(III), Sm(III), Yb(III), Zn(II), Ni(II), Fe(II), Th(IV), and Cu(II)] was studied in regard to pH and the flow rate using the sodium type of cation exchange resin (Dowex 50-X_4, 50 to 100 mesh). Separation and concentration of these complex were possible over a pH range 4 to 1. The separation of Th(IV) and Yb(III) (pH = 1.65) and Sm(III) and Cu(II) (pH = 1.90) was possible. (auth)

37481 EXTRACTION OF THORIUM FROM NITRATE SOLUTIONS BY 1,3,4,5-TETRASUBSTITUTED PYRAZOLES. Dziomko, V. M.; Avilina, V. N.; Ivanov, O. V. Zh. Neorg. Khim.; 16: No. 5, 1401-6(May 1971). (In Russian).

The extraction of Th(IV) from nitrate solutions by 1,3,4,5-tetrasubstituted pyrazoles was studied as a function of the concentration and nature of the substituent, the character of the diluent, and the structure of the amines. It was demonstrated that Th extraction depends on the length of the alkyl substituent on the pyrazole ring, and on the character of the N-substituent. A complex having Th(IV): pyrazole ratio of 1:2 forms in the organic phase. (tr-auth)

37482 PRESENT STATUS OF RECOVERY OF URANIUM. RECOVERY OF URANIUM BY BACTERIAL LEACHING. Kurihara, K. (Fermentation Research Inst., Chiba, Japan). Genshiryoku Kogyo; 16: No. 12, 23-7(Dec 1970). (In Japanese).

Bacterial leaching and the present status of its utilization in American and Japanese metal mines are described. The use of bacterial leaching in the Lake Elliot district, Canada, to raise the recovery rate of uranium since the early 1960s is discussed. In these mines, sulfide ores of uranium are leached with percolators using high-pressure mine water. The enriched mine water is then sent to recovery plants, and there uranium is extracted by current processes. Experiments on the bacterial leaching of Ningyô-tôge ores revealed a marked effect of the bacterial leaching as applied to them. (Japan)

37483 PRESENT STATUS OF RECOVERY OF URANIUM. RECOVERY OF URANIUM IN SEA WATER. Ogata, N. (Japan Monopoly Corp., Tokyo). Genshiryoku Kogyo; 16: No. 12, 19-22(Dec 1970). (In Japanese).

The status of investigation of uranium recovery from seawater is reviewed. Recent values of uranium content in seawater are from 0.0030 to 0.0035 ppM, and the total amount of uranium in the world's seawater is estimated as 4,500 million tons. English investigators recently obtained 550 μg of uranium per lg of titanium, using titanic acid adsorbent. Inoue and Kakibara reported 1550 μg of adsorbed uranium per 1 g of titanium, using titanic acid by a thermal dissociation process. This method is explained together with the method that uses titanic acid prepared from a neutralization process. Factors that have great effects on the adsorption of uranium in seawater, such as temperature and amount of contacting seawater, are discussed. (Japan)

37484 CHROMATOGRAPHIC SEPARATION OF NIOBIUM FROM ACCOMPANYING ELEMENTS. Gibalo, I. M.; Mymrik, N. A. (Moscow State Univ.). Zh. Anal. Khim.; 26: No. 5, 918-21(May 1971). (In Russian).

A method was developed for separating niobium from various amounts of iron(III), tin(IV), zinc, rhenium(VII), cobalt, and rare earths (lanthanum, cerium, ytterbium) on a column in the systems of 2M HCl–tri-n-octylamine and 11M HCl–tri-n-octylamine. The separation coefficients for niobium and accompanying elements were calculated. (auth)

37485 USE OF ANTIPYRINE AND OF ITS DERIVATIVES IN ANALYTICAL CHEMISTRY (A REVIEW). Akimov, V. K.; Busev, A. I. (Moscow State Univ.). Zh. Anal. Khim.; 26: No. 5, 964-74(May 1971). (In Russian).

The use of antipyrine and its derivatives in analytical chemistry is reviewed. The extraction of metals, including thorium and uranium, is discussed. (263 references) (J.G.B.)

37486 ACIDIC ORGANOPHOSPHORUS EXTRACTANTS. XIV. EXTRACTION OF STRONTIUM AND SODIUM BY n-OCTYL HYDROGEN PHENYLPHOSPHONATE. Sistkova, N. V.; Kolarik, Z.; Chotivka, V.; Pankova, H. (Nuclear Research Inst., Rez, Czech.). J. Inorg. Nucl. Chem.; 33: 1139-50(Apr 1971).

Strontium and sodium are extracted by n-octyl hydrogen phenylphosphonate with cyclohexane diluent as the complexes $SrA_2 \cdot 3HA$ and $NaA \cdot 3HA$ respectively (with HA denoting the monomeric molecule of the extractant) at a very low loading of the organic phase with sodium; at a higher loading, polymeric complexes $mNaA \cdot nHA$ and mixed complexes $SrA_2 \cdot uNaA \cdot vHA$ are supposed to be formed in the organic phase. The complex $SrA_2 \cdot 3HA$ prevails in the organic phase at low loadings also in using n-heptane, CCl_4, and toluene diluents, while the coexistence of this complex with $SrA_2 \cdot 2HA$ was observed in using n-butyl ether diluent. (auth) (UK)

37487 STUDIES OF SOLVENT EXTRACTION BEHAVIOR OF SOME DIVALENT METALS WITH LIQUID ION-EXCHANGER. De, Anil K.; Ray, Uday Sankar (Visva-Bharati, Santiniketan, India). Separ. Sci.; 6: No. 3, 443-50(Jun 1971).

A systematic study of the comparative extraction behavior of some divalent metals, Fe, Zn, Cd, Hg, Pb, Pd, Mg, Ca, and Sn, was carried out with a high-molecular-weight carboxylic acid, namely SRS-100. Benzene was used as diluent. The study included the extraction behavior as a function of pH, effect of diluent, metal ion concentration, solvent concentration, and finally interference of the associated elements. In almost all cases nearly quantitative extraction was achieved. The proposed method is very simple, rapid, and applicable both at micro and macro levels. The method is applicable to extraction of metal ions in the presence of other commonly interfering ions present at the milligram level. (auth)

37488 PAPER CHROMATOGRAPHIC AND ELECTROCHROMATOGRAPHIC SEPARATION OF EDTA COMPLEXES OF METAL IONS. Qureshi, Mohsin; Rawat, J. P. (Aligarh Muslim Univ., India). Separ. Sci.; 6: No. 3, 451-4(Jun 1971).

R_F values of EDTA complexes of some metal ions in seven solvent systems are given. The separation of Al and Be EDTA complexes has been achieved in different ratios by paper chromatography. Paper electrophoresis was also performed in four solvent systems to study the separation of EDTA complexes of metal ions. (auth)

37489 PURIFICATION PROCESS FOR SOLUTIONS CONTAINING URANIUM FROM FUEL REPROCESSING. Defrance, Roger (to Ugine Kuhlmann). French Patent 2,034,330. 11 Dec 1970. Filed 17 Mar 1969. (In French).

A process is presented for purifying already treated aqueous solutions containing hexavalent uranium. This process enables half of the remaining Pu to be eliminated, or in some cases the entire quantity, as well as traces of Co, Cu, Mo, W, Ta, Zr, and Zn. An aqueous solution of hexavalent uranium was put in contact for at least 15 minutes with a recently prepared (preferably under damp conditions) lanthanide or actinide fluoride. This contact can be achieved by dispersing the fluorides in very fine powder form in the solution to be purified, or by percolating the solution through a column of granulated fluoride. (auth) (France)

37490 STRONTIUM EXTRACTION PROCESS. Schulz, Wallace W. (to United States Atomic Energy Commission). U. S. Patent 3,574,531. 13 Apr 1971. Filed 15 May 1969.

XUM

A process is described for recovering strontium and lanthanide rare earth values from an aqueous nuclear reactor fuel reprocessing waste solution containing these and other values by adjusting the pH, adding a buffering agent and a complexing agent, which will complex all cations present except the alkali and alkaline earth metals, to the waste solution and contacting the aqueous feed solution so obtained with an organic extractant consisting of di(2-ethylhexyl) phosphoric acid and dibutyl butylphosphonate in a hydrocarbon diluent to extract the Sr and rare earth values. (auth)

37491 RECOVERY OF URANIUM IN JAPAN. PRESENT STATUS OF RECOVERY OF URANIUM. Takenaka, Shunzo (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo: 16: No. 12, 4-14(Dec 1970). (In Japanese).

An experimental investigation of ore dressing and refinement processes of uranium was performed and the through process (PNC process) of refinement, without making yellow cakes, by means of ion exchange and amine extraction (AMEX) in combination, was accomplished. An experimental refinery using this process was installed in the Ningyðtðge mine. Various improvements were made in both ore dressing and refining processes. Mixing with sulfuric acid, heating, and extracting with cold water to increase the recovery rate from clayey ore are discussed along with other effective devices in use in various parts of the processes. This method of recovery was selected because of the nature of the sedimentary uranium ores of Nigyðtðge and other districts, in which uranium minerals are contained as fine particles in sandy or muddy cementing gravels or in their fissures, and produce very friable clayey ore materials. Chemically, uranium is first extracted as uranyl sulfate, and this is converted to uranyl chloride, which is then reduced to uranous chloride, and, by adding fluoric acid, uranium fluoride ("green salt") is obtained. (Japan)

37492 THERMODYNAMIC PROBLEMS INVOLVED IN THE CONCENTRATION BY COPRECIPITATION AND SEPARATION OF MICROAMOUNTS OF RADIOACTIVE ATOMIC SPECIES. I. Imre, Lajos (Kossuth Univ., Debrecen, Hungary). Kem. Kozlem.: 35: No. 1, 33-67(1971). (In Hungarian).

A thermodynamic approach was used to analyze solid–liquid interface problems in which adsorption ions are held at the solid lattice surface by ionic-bond type valence forces. The thermodynamic isotherm constant of such Langmuir-type adsorption processes may be correlated with the solubility of the adsorption compound created by the ionic species and the opposite, lattice-generating ions, regardless of whether exchange- or no-exchange-type reactions are involved. This is explained by postulating that the adsorption is not due to one-dimensional interactions between the lattice and the adsorption ions but are the result of nucleation processes at the interface. Fractional crystallization experiments were carried out with the $(BaSO_4)_{macro} - {}^{212}Pb(ThB^{2+})_{micro}$; $(BaSO_4)_{macro} - ({}^{51}CrO_4^{2-})_{micro}$; $(PbSO_4)_{macro} - ({}^{89}Sr^{2+})_{micro}$; $(PbSO_4)_{macro} - ({}^{140}Ba^{2+})_{micro}$ Doerner–Hoskins systems and the $(PbI_2)_{macro} - ({}^{82}Br^{-})_{micro}$ Henderson–Kracek system. The theory was experimentally confirmed by the observation that the interface equilibria determined the ultimate composition of the mixed crystals that contained the radioactive microcomponents of the system. The findings were found to be applicable also to the Henderson–Kracek-type systems. (TTT)

37493 LEACHING OF CHALCOPYRITE ($CuFeS_2$) WITH SODIUM CHLORIDE SULFURIC ACID SOLUTIONS. Munoz-Ribadeneira, Fausto J.; Gomberg, Henry J. (Puerto Rico Nuclear Center, Mayaguez). Nucl. Technol.; 11: No. 3, 367-71(Jul 1971).

Chalcopyrite-type ore samples, 200-mesh size (−105, +74 micros) were placed in hermetically sealed screw cup flasks, in contact with a solvent made up of sulfuric acid (1N) and sodium chloride at different concentrations. Data indicate an appreciable dissolution of the copper in the ore in a reasonable leaching time. The experiments were carried out at room temperatures. No agitation was used. Data for copper dissolution can be represented by a rate equation that is first order, in copper concentration, and the rate of copper dissolution is also a function of the chloride ion concentration. The advantages of this solvent, if used in Plowshare leaching in situ mining technology, are briefly discussed. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 37319, 37548, 37662, 37664, 37807, and 37826.

37494 MEASUREMENT OF ATTENUATION OF ^{137}Cs AND ^{241}Am GAMMA RAYS FOR SOIL DENSITY AND WATER CONTENT DETERMINATIONS. Corey, J. C.; Peterson, S. F.; Wakat, M. A. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Soil Sci. Soc. Amer., Proc.; 35: 215-19(Mar-Apr 1971).

Soil density and water content can be determined concurrently by measuring the attenuation of two different gamma energies. A dual source containing ^{241}Am and ^{137}Cs was shown to be suitable for these measurements. Multichannel pulse-height analyzers were evaluated to determine their accuracy under experimental conditions for simultaneous measurements of soil density and water content. NaI(Tl) and Ge(Li) detectors were also evaluated. The measurements were made with a collimated beam, 1 cm in diameter, of 662-keV gamma rays and 59.6-keV gamma rays from a source containing 70 mCi of ^{137}Cs and 29 mCi of ^{241}Am. Measured mass attenuation coefficients were 0.08565, 0.07803, and 0.07887 cm^2/g for cesium gamma rays and 0.20493, 0.27100, and 0.33480 cm^2/g for americium gamma rays with water, Cecil, and Houston Black soil, respectively. The higher resolution of the Ge(Li) detector and a 4096-channel pulse-height analyzer had no significant advantage with peaks as widely separated as 662 keV and 59.6 keV. A NaI(Tl) detector and a 400-channel pulse-height analyzer were satisfactory. With the multichannel pulse-height analyzer, it was simpler to adjust the area under the americium peak for the Compton contribution from the cesium radiation than with a single channel pulse-height analyzer. Water content and density changes in both a swelling and nonswelling soil illustrate the utility of the system. (auth)

37495 ^{208}Tl AND ^{24}Na GAMMA SOURCES FOR IDENTIFYING SOIL WATER TAGGED WITH DEUTERIUM. Hawkins, R. H.; Overman, R. F.; Corey, J. C. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Soil Sci. Soc. Amer., Proc.; 35: 199-201(Mar-Apr 1971).

In situ tracing of soil water movement with the D_2O–^{24}Na method has been limited by the need to reactivate the ^{24}Na gamma source frequently (half-life of 15 hours) in a nuclear reactor. Our laboratory study showed ^{208}Tl produced the same neutron count rates from vials of D_2O in dry and moist soil as did ^{24}Na. The 1.9-year effective half-life of ^{208}Tl in equilibrium with its parent nuclide ^{228}Th is a significant advantage of ^{208}Tl over ^{24}Na. Recent commercial availability of ^{208}Tl sources now makes in situ D_2O tracing of soil water feasible for investigators not having access to a nuclear reactor. (auth)

37496 NATIONAL AND INTERNATIONAL ENVIRONMENTAL MONITORING ACTIVITIES. A DIRECTORY. Cambridge, Mass.; Smithsonian Institution Center for Short-Lived Phenomena (1970). 306p. $10.00.

A directory of operational and proposed international environmental monitoring activities and of the environmental monitoring activities in each of 149 countries is presented. The operational international monitoring activities include programs for monitoring solar radiation, atmospheric ozone, air pollution, climatic conditions, tsunami occurrence, fallout, seismic activity, atmospheric electricity, soil and marine environment, etc. (L.C.L.)

37497 DISTRIBUTION OF ^{90}Sr AND ^{137}Cs IN THE SOIL AND VEGETATION COVER OF THE TUNDRA. Molchanova, I. V.; Kulikov, N. V. (Inst. of Plant and Animal Ecology, Sverdlovsk, USSR). Dokl. Akad. Nauk SSSR; 195: 959-61(1 Dec 1970). (In Russian).

The distribution of radioisotopes in the soil and vegetation of the European section of the USSR has been studied but little is known on this subject with respect to the Far North and especially the tundra region; therefore, a comparative study was carried to determine the distribution of ^{90}Sr and ^{137}Cs in various types of soils and vegetation of the tundra. The examined area included peaks, moraine ranges and foothills of the watershed together with marshy peat-bog areas. During July 1966, specimens were collected from each of the soil types and from the vegetation which consisted mostly of moss and lichen. The ^{90}Sr content of the collected samples was determined radiochemically from the concentration of the ^{90}Y daughter product; the ^{137}Cs concentration was determined by means of a multichannel γ analyzer. The results indicated that these radioisotopes are primarily concentrated in the plants; ^{90}Sr which has a tendency to migrate is accumulated in the soil. (TTT)

Meteorology

Refer also to abstracts 37314, 37496, 37509, 37510, 37513, 37562, 37699, 37731, 37744, 37745, 37750–37753, 37769–37771, 37787–37789, 37792, 37793, and 37796.

37498 (BNWL–1551(Pt.2), pp 27-30) IN-CLOUD SCAVENGING. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

Rainwater concentrations of the cosmogenic radionuclides ^{24}Na, ^{36}Cl and ^{39}Cl and their production rates from argon were measured in studies of the rates and mechanisms of in-cloud processes such as raindrop nucleation and precipitation scavenging. (auth)

37499 (BNWL–1551(Pt.2), pp 35-45) RADIOACTIVE FALLOUT RATES AND MECHANISMS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

The concentrations of trace elements, cosmogenic radionuclides, and nuclear-weapons-produced radionuclides were measured in the air from ground-level to 19 km and in rain and seawater in order to determine the origin and chemistry of the atmospheric aerosol and to study the rates of atmospheric and oceanic mixing, the rates of air-sea interchange, and the rates and mechanisms of precipitation scavenging. (auth)

37500 (BNWL–1551(Pt.2), pp 63-4) TRACER STUDIES IN THE NORTHEAST COLORADO HAIL EXPERIMENT PROGRAM. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

Studies of the cloud dynamics and microphysics of severe convective storms are being made through measurements of cosmic-ray-produced radionuclides, trace elements, and added inert or radioactive tracer elements to identify effective means of modifying those storms that produce damaging hail fall and to determine whether the chosen modification methods are technically and economically feasible. (auth)

37501 DISCUSSION OF PAPER BY W. R. SCHELL, G. SAUZAY, AND B. R. PAYNE, TRITIUM INJECTION AND CONCENTRATION DISTRIBUTION IN THE ATMOSPHERE. Scholz, T. G. (National Center for Atmospheric Research, Boulder, Colo.). J. Geophys. Res.; 76: 2206-11(20 Mar 1971).

Comments are given on a paper published previously concerning tritium injection and concentration distribution in the atmosphere. The paper was abstracted in NSA as 24: 25140. (G.M.C.)

Mineralogy and Exploration

37502 (A/CONF.49/P–59) OUTLOOK FOR URANIUM PRODUCTION TO MEET FUTURE NUCLEAR FUEL NEEDS IN THE UNITED STATES. Faulkner, Rafford L. (Division of Raw Materials (AEC), Washington, D. C.). Sep 1971. 17p. (CONF-710901–9). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The results of uranium exploration in the U.S.A. from 1966 onward in the light of expected nuclear-fuel needs are reviewed and their meaning is examined with respect to future U. S. uranium discovery possibilities, including the geologic basis for the location, evaluation, and magnitude of favorable areas. Present and future exploration and production are discussed. Thorium supply and demand are very briefly discussed. Requirements for thorium apparently will be small for the next two decades or more relative to requirements for uranium and for the known low-cost resources. (L.C.L.)

Oceanography

Refer also to abstracts 37496, 37625, and 37670.

XUM

37503 (BNWL-1551(Pt.2), pp 12-22) PHYSICAL AND RADIOLOGICAL CHEMISTRY OF OCEAN SOLUTIONS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

The concentrations, distributions and behavior of the oceans' trace elements and natural and artificial radionuclides were investigated. The characterization of these constituents in the marine environment contributes to a better understanding of ocean mixing, vertical transport, and the biogeochemical and physical processes affecting the apportionment and fate of the oceans' radioactive and stable elements. (auth)

37504 (BNWL-1551(Pt.2), pp 23-6) GEOCHEMICAL OCEANS SECTIONS STUDY (GEOSECS). (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

GEOSECS is a multidisciplinary detailed study of the properties and constituents of the same water samples to be taken from depth profiles on tracks along the western boundaries of the major oceans. Battelle-Northwest's contribution includes programs to measure trace element, ^{7}Be, and fallout radionuclide distributions in order to determine their world-wide oceanic deposition and calculate the vertical transport of different water masses from the vertical concentration gradients. To date two intercalibration cruises, one in the Pacific and one in the Atlantic, have been conducted for the purpose of coordinating the different GEOSECS programs and intercomparing the methods and precision for measuring the multitude of oceanic properties to be studied. Results of an interlaboratory comparison of trace element methodology are reported, together with radionuclide distributions in water columns sampled in the Atlantic Ocean. (auth)

Seismology

Refer also to abstract 37496.

37505 (NVO-1163-TM-24) COVARIANCE ANALYSIS OF RESPONSE SPECTRA. Lynch, Robert D. (Environmental Research Corp., Las Vegas, Nev.). May 1971. 66p. Dep. NTIS.

Pseudo relative velocity response spectra, derived from 26 horizontal components of ground motion at 13 recording stations, are analyzed using a statistical model known as analysis of covariance. The analysis generates, as a function of period, yield scaling exponents and sigma values which are characteristic of the total data sample. The statistically determined yield scaling exponents agree well with theoretically determined exponents. Individual amplitude coefficients for each station-component data sample are determined. These coefficients reflect the characteristics of the transmission path between the source and recording stations. Data are presented which demonstrate that considerable variability in the mean spectrum can be attributed to the transmission path. (auth)

37506 (UCRL-Trans-10436) SEISMIC VIBRATIONS DUE TO EARTHQUAKES AND EXPLOSIONS. Aptikaev, F. F. Translated for Univ. of California Lawrence Radiation Lab., Livermore, from Seismicheskie Kolebaniya pri Zemletryaseniyakh i Vzryvakh, Izdatel'stvo Nauka, Moscow, 1969. 121p. Dep. NTIS.

The energy release problem for both earthquakes and explosions is examined using both seismic data measured in the USSR and data published in the U. S., particularly data on the seismic aspects of the Plowshare Program. The various topics discussed include: description of seismic sources; the seismic energy of an explosion; wave characteristics and propagation from seismic events; and the application of the theory of similarity to the study of seismic vibrations. (L.C.L.)

37507 SMALLER AFTERSHOCKS OF THE BENHAM NUCLEAR EXPLOSION. Stauder, William (St. Louis Univ.). Bull. Seismol. Soc. Amer.; 61: No. 2, 417-28(Apr 1971).

The examination of the BENHAM aftershocks is extended to 162 earthquakes approximately an order of magnitude smaller than those previously studied. The spatial distribution of these smaller events is similar to that found for larger events examined by Hamilton and Healy (1969). Focal mechanisms are also similar to those of the larger aftershocks: dip-slip along northeasterly trending zones and generally strike-slip along a north-south trending zone west of the shot-point. About one third of the mechanism solutions are ambiguous, capable of either interpretation. Amplitude data are successfully used to resolve the ambiguity in about one half of these cases by selecting the solution which gives a notably lesser value of the variance, $\Sigma\ (A_{i,obs} - kA_{i,calc})^2/N$ of the amplitude residuals. The value of k is related to the magnitude of the shocks. A b value of 1.09 indicates that aftershocks of the explosion follow a recurrence rate normal for regional earthquakes or aftershock sequences. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 37493, 37507, 37688, 37727, and 38537.

37508 (NVO–1229-106(Pt.1)) EVALUATION OF THE PROJECT GNOME/COACH SITE CARLSBAD, NEW MEXICO FOR DISPOSITION, INCLUDING IDENTIFICATION OF RESTRICTIONS. Gardner, M. C.; Sigalove, J. J. (Teledyne–Isotopes, Palo Alto, Calif.). Sep 1970. Contract AT(29-2)-1229. 53p. Dep. NTIS.

The Project Gnome/Coach site, in Eddy County southeast of Carlsbad, New Mexico, was examined to determine the physical safety and security considerations and for disposition from U. S. Atomic Energy Commission proprietorship. The Gnome device was detonated on December 10, 1961, with a yield of 3.0 ± 0.5 kilotons. Current structural, radiochemical, and security aspects of the resultant conditions were studied from available sources. An evaluation was made according to safety criteria and systems analysis devised by Teledyne Isotopes for general use in disposition studies. Radioactive materials at the site surface were cleaned up and dumped into the cavity and shaft. Subsurface radioactive materials are confined to the detonation cavity, drifts, shaft, and drill holes. The shaft, drifts, and drill holes were filled and sealed. Analysis of hydrologic and lithologic conditions indicates that complete isolation will continue. Collapse of the cavity roof and consequent chimney formation is improbable but possible. If collapse did occur, rock material would stope to about 40 meters (130 feet) below the Salado salt beds' upper surface; a significant buffer of impermeable formation would remain. The Culebra Dolomite Member of the Rustler Formation is the only known persistent aquifer in the area. No radionuclides are forecast to enter the formation. If water-borne radioactivity entered the formation, levels of activity would decay below one CG level within the area of restricted drilling and well before the present (1970) nearest downgradient private wells were reached. The site is recommended for release, with exclusion of drilling or digging within 450 meters (1475 feet) of the cavity, drifts, and shaft. This exclusion is for security purposes. No further use of the cavity, drill holes, shaft, or drifts is recommended. (auth)

37509 (PNE–1008) WEATHER PREDICTIONS AND SURFACE RADIATION ESTIMATES FOR THE GASBUGGY EVENT. Final Report. Armstrong, Robert H.; Morrell, Joseph R. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Air Resources Lab.). 21 May 1971. Contract SF-54-351. 56p. (PNE-G–75). Dep. NTIS.

Meteorological and radiological forecasts for Project Gasbuggy were prepared by personnel of the Air Resources Laboratory-Las Vegas. Three surface wind towers, located near Gasbuggy surface ground zero, provided automatic measurements of surface wind speed and direction. These measurements were radio-telemetered to a master station in the weather trailer at the Control Point (CP). A 24-hour weather observing station, equipped to take upper-air soundings of wind, temperature, humidity, and pressure along with surface observations, became operational in the CP area two weeks prior to the event. Upper-wind observations were taken at three locations peripheral to the site. Large-scale meteorological data and forecasts from the National Meteorological Network were received at the weather forecast office in the CP. Event-oriented forecasts of winds, weather, vertical atmospheric stability, and air trajectories as well as estimates of potential radiation effects were presented to the Test Manager and his Advisory Panel in daily formal and informal briefings beginning at D-3 days. Intensive surveillance of meteorological conditions at the surface and aloft throughout the entire area of concern was maintained on D-Day. The Test Manager and his Advisory Panel were kept informed of current and predicted meteorological conditions starting with the final readiness briefing and continuing throughout the day. D-Day meteorological data are included as an appendix. (auth)

37510 (UCRL-Trans–10517) NUCLEAR EXPLOSIONS FOR PEACEFUL PURPOSES. A Collection of Articles. Morokhov, I. D. (ed.). Translated for Univ. of California Lawrence Radiation Lab., Livermore, from Atomnye Vzryvy v Mirnykh Tselyakh, Atomizdat, Moscow, 1970. 190p. Dep. NTIS.

Several articles by Russian authors on industrial uses of underground nuclear explosions and phenomena associated with underground nuclear explosions are presented. These include: studies of single and multiple nuclear excavation explosions; the influence of the surrounding media on the effects of underground nuclear explosions; long range contamination from underground nuclear explosion fallout; atmospheric contamination by radioactive gases released from cratering explosions; a model for calculating fallout dispersion following an underground nuclear explosion; and atmospheric and soil contamination from single and multiple nuclear cratering explosions. (L.C.L.)

37511 NEUTRONS FROM NUCLEAR EXPLOSIONS. Hemmendinger, Arthur (Los Alamos Scientific Lab., N. Mex.). Amer. Sci.; 58: No. 6, 622-33(Nov-Dec 1970).

The economics of using nuclear explosions for producing neutrons for time-of-flight experiments were investigated. It was concluded that the cost of producing 10^{16} neutrons in short pulses is approximately 20¢ using a nuclear detonation as compared to $3,000 using a modern accelerator. (auth)

37512 DISTRIBUTION, RESIDENCE TIME, AND INVENTORY OF TRITIUM IN SEDAN CRATER EJECTA. Martin, J. R.; Koranda, J. J. (Univ. of California, Livermore). Nucl. Technol.; 11: No. 3, 459-65(Jul 1971).

The distribution and fate of residual radioactivity in earth moved by nuclear explosives are important considerations in nuclear civil engineering. The Sedan cratering experiment conducted in the Nevada desert provided a natural ecosystem in which to study these criteria. Radioecological studies conducted over a five-year period have characterized the distribution and residence time of tritium in the Sedan crater ejecta. These studies demonstrate that an ecological approach can provide descriptive and functional data which may be applied to the development of nuclear-explosive technology. (auth)

37513 RADIONUCLIDE DISTRIBUTION IN THE PARTICLE POPULATION PRODUCED BY THE SCHOONER CRATERING DETONATION. Heft, Robert E.; Phillips, William; Steele, William (Univ. of California, Livermore). Nucl. Technol.; 11: No. 3, 413-43(Jul 1971).

The radionuclide distribution in the Schooner Event can be understood in terms of a three-stage condensation process which produces two distinct particle classes, each of which has a uniform isotopic composition. One class of particles results from the breakup of the molten cavity liner and carries that fraction of each radionuclide which was condensed in the molten liner at vent time. The other class of particles is produced by the crushing action of the shock wave on the overburden material. This class of particles carries as a surface deposit that fraction of each radionuclide which was in the vapor state at vent time. The vapor/condensed state partitioning may be interpreted as a two-phase equilibrium in which the equilibrium constant is given by Henry's Law. The distributions with particle size of the individual radionuclides in the whole particle population are expressed as linear combinations of two lognormal distribution functions which correspond to the two particle classes. For a given radionuclide and a particular particle size, the fraction which appears in the main cloud (and base surge) decreases exponentially as the square of particle diameter increases. Transport and deposition of airborne radioactive particulates for many hours after detonation are described in terms of Stokesian fall rates and horizontal diffusion. (auth)

37514 CHEMISTRY OF THE GASBUGGY CHIMNEY. Duff, Russell E.; Schalit, Lew (Applied Nuclear Co., La Jolla, Calif.). Nucl. Technol.; 11: No. 3, 390-9(Jul 1971).

A model was developed to explain the composition of gas withdrawn from the Gasbuggy chimney following an underground nuclear explosion to stimulate the recovery of natural gas. The model assumes that homogeneous, gas phase reactions occurred during cavity formation among the species formed from the volatile fraction of 1550 tons of formation per kiloton of explosive yield. After chimney collapse, additional heterogeneous reactions occurred involving this gas mixture and natural gas which significantly altered the composition. Two criteria for choosing the shot points for future explosions are suggested; the rock should be free of solid carbon, and relatively rich in carbonates. The application of these criteria is expected to reduce significantly the radioactive burden of T and ^{14}C found in the hydrocarbons subsequently produced. (auth)

37515 MICROFRACTURING IN POSTSHOT GASBUGGY CORE GB-3. Borg, I. Y. (Univ. of California, Livermore). Nucl. Technol.; 11: No. 3, 379-89(Jul 1971).

Microfracturing in shocked sedimentary rocks near to the 29-kt Gasbuggy nuclear explosion has been microscopically examined in samples from postshot core (Hole GB-3). Of four reentered or drilled postshot holes, GB-3 makes the closest approach to the shot point (198 ft radial distance or approximately 2.47 times the cavity radius). The amount of fracturing in rock more than 200 ft

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from the shot point is small and shows little correlation with distance. Calculated maximum peak stresses for the rock are in the 6 to 8 kb range and are below the laboratory-measured yield strengths. Comparison of shock effects in brittle granodiorite and in the semi-brittle Gasbuggy rocks at the same peak radial stresses indicates that matrix fracturing in the granodiorite is many times greater than in the Gasbuggy rocks. It points up the important role played by weak, ductile cementing minerals in the latter in determining the mode of yielding of the whole. (auth)

37516 MARVEL EXPERIMENT. Crowley, B. K.; Glenn, H. D. (Univ. of California, Livermore). Nucl. Technol.; 11: No. 3, 372-8(Jul 1971).

The Marvel experiment was conducted at the Nevada Test Site in a horizontal, air-filled tunnel 1 m in diameter and 122 m long, 176 m below the surface. A 2.2-kt nuclear device was detonated at one end of the tunnel. The primary purpose of Marvel was to develop experimental and calculational techniques for understanding energy propagation in a nonspherical initial geometry. The Marvel experiment, some of the experimental techniques used, and the agreement of the numerical calculations with the experimental data are briefly described. The favorable comparison between experimental data and the calculations implies that the calculations can be used as a predictive technique for similar non-spherically emplaced experiments. (auth)

37517 SOVIET PROGRAM ON NUCLEAR EXPLOSIVES FOR THE NATIONAL ECONOMY. Werth, Glenn C. (Univ. of California, Livermore). Nucl. Technol.; 11: No. 3, 280-301(Jul 1971).

Seven recent Soviet publications describe their program on the peaceful uses of nuclear explosives. Nine applications are under development: the creation of water reservoirs, control of gas well blowouts, stimulation of oil reservoirs, creation of underground storage, stimulation of gas reservoirs, breaking of rock for underground mining, formation of canals, removal of overburden for mining, and construction of dams. Eleven nuclear projects have been carried out, involving fifteen nuclear explosives. Three applications have been reduced to practice. Nine proposed nuclear projects are described. In carrying out these projects, the Soviets make extensive technical measurements. Analyses of these measurements, with laboratory model experiments and theoretical work, are used to project the economic benefit to the Soviet economy that is possible by employment of nuclear explosives. (auth)

37518 USE OF MULTIPLE NUCLEAR EXPLOSIVES FOR GAS STIMULATION. Nordyke, Milo D. (Univ. of California, Livermore). Nucl. Technol.; 11: No. 3, 303-14(Jul 1971).

An analysis of the use of multiple nuclear explosives in a single emplacement hole for the stimulation of the production of natural gas from a low permeability gas reservoir was made. Both simultaneous and sequential firing were considered. Although the physical effects of simultaneous or sequential firing are difficult to quantitatively predict, it is shown that, for an area where the gas deposit is thick (>500 ft) and the maximum yield is limited by seismic considerations, the use of sequential firing is significantly more advantageous from an economic viewpoint. An economic analysis of a specific gas formation was made, assuming the use of sequential explosions for the commercial development of an entire gas field. Assuming a wellhead gas price of 30¢ per 1000 ft^3, the internal rate of return on the required investment varied from 13% to 27%, depending on the properties of the reservoir. Before these projections can be realized, a large number of technical and operational problems must be solved. (auth)

37519 PLOWSHARE AND THE ENVIRONMENT. Holzer, Alfred (Univ. of California, Livermore). Nucl. Technol.; 11: No. 3, 315-22(Jul 1971).

Deeply-buried underground nuclear explosions used in the recovery of minerals and natural gas can have a positive impact on the environment. To put this on a quantitative base, one can compute emissions from a hypothetical 1000 MWe plant using coal, oil, or nuclearly-stimulated gas and examine the relative effects downwind from the plant. The trade-offs between SO_2 emissions from coal and oil, and tritium and krypton from the nuclearly-stimulated gas can then be evaluated under identical conditions. Using natural gas, the plant energy requirement of 90 billion ft^3 per year can be met by a field development consisting of 15 wells the first year and decreasing to 2 wells per year after five years. Four 100-kt explosives are assumed needed to stimulate each well. Tritium and krypton-85 concentrations are computed to decrease from first-year values of 10 pCi/cm^3 and 52 pCi/cm^3, respectively, to 1.4 and 7.2 pCi/cm^3 after five years, as new formation gas replaces the original chimney gas and the number of new wells decreases. For the reasonable meteorological conditions which are assumed to remain constant, the maximum effluent concentration occurs 4.3 km from the plant. There the ground-level values of SO_2 for coal, oil, and natural gas use are 0.18, 0.044, and 0.00002 parts per million, respectively. Converting the radionuclide concentration at the same location to dose shows that whole-body tritium doses decrease from 0.14 mrem/year for the first year to 0.018 mrem/year after six years, and that the whole-body krypton-85 dose decreases from 0.009 to 0.001 over the same time span. These doses can be compared with those from natural and man-made radioactive sources. The annual dose from a power plant using nuclearly-stimulated natural gas is comparable to that from TV sets and luminous dial watches. (auth)

37520 NEED FOR PLOWSHARE GAS. Smith, Sam (El Paso Natural Gas Co., Tex.). Nucl. Technol.; 11: No. 3, 331-4(Jul 1971).

Natural gas satisfies approximately one-third of the nation's energy requirements, but domestic gas reserves are declining because the volume being consumed exceeds the quantity being discovered. Unrealistically low regulated wellhead prices have stimulated demand while eliminating the economic incentives needed to compensate for the risks associated with exploration. Natural gas is a particularly important energy resource because it is the cleanest of the fossil fuels. Increased use of natural gas by industry, for electric power generation and as a transportation fuel could substantially improve air quality. However, current supply limitations foreclose such possibilities. Other methods of securing additional supplies of natural gas include pipeline imports from Canada and Alaska and imports of liquefied natural gas from Alaska and foreign sources. Coal gasification technology is expected to supplement supply by 1980. These alternatives are costly and most will not be available for a number of years. Nuclear explosive stimulation technology is capable of making a significant and needed contribution to natural gas supply if supported by federal planning and funding. (auth)

37521 RECOVERY OF HIGH-VISCOSITY PETROLEUM BY STEAM FROM GEOTHERMAL HEAT. Paz-Castillo, Fernando; Kruger, Paul (Stanford Univ., Calif.). Nucl. Technol.; 11: No. 3, 345-56(Jul 1971).

Steam stimulation is an efficient means of increasing recovery of petroleum from high-viscosity tar-sands deposits. Large amounts of steam are required with costs averaging about $0.50 per barrel. The economic development of many deposits depends on the availability of low cost steam. Geothermal heat has been considered as a source for producing steam. The feasibility of using a nuclear explosion in a geologic formation with normal temperature gradient for steam production near tar-sands deposits has been explored. A rubble chimney can be created at a depth of burial such that the temperature difference between the formation and the tar sands would be sufficient to reduce the viscosity of the oil for commercial recovery. Calculations indicate that a large tar-sands deposit in Venezuela could be steam stimulated to produce about 18 million barrels of oil. A 1 Mt nuclear explosion at a depth of burial of 3340 m might allow steam extraction of more than 10^{12} Btu at an estimated cost of less than $0.50 per barrel of steam produced. (auth)

Facilities and Equipment

Refer also to abstracts 37394, 37834, 37842, and 37931.

37522 (LA–4650) FILTER EFFICIENCY vs PARTICLE SIZE AND VELOCITY. Stafford, Ronald G.; Ettinger, Harry J. (Los Alamos Scientific Lab., N. Mex.). Mar 1971. Contract W-7405-Eng-36. 7p. Dep. NTIS.

Several commercial filter media were evaluated for efficiency as a function of particle size and velocity. Particle size and velocity producing minimum efficiency are different for each media and are well below single fiber theoretical predictions. Experimental efficiencies were generally higher than theoretical total mat efficiencies. (auth)

37523 (NP–18816) STUDY ON THE GENERAL SHOPS OF THE MEXICAN NUCLEAR CENTER. Quinones, Sergio Rodriguez (Instituto Politecnico Nacional, Mexico City. Escuela Superior de Ingenieria Mecanica y Electrica). 1966. 180p. (In Spanish). Dep. NTIS (U. S. Sales Only).

Thesis.

The need for and types of workshops planned for the Mexican Nuclear Center and their basic equipment are described. The use of lead in these facilities is considered. The economic aspects of the facilities are also discussed. (J.S.R.)

37524 (TID–4100(Suppl.63)) ENGINEERING MATERIALS LIST. Supplement 63. Smith, Richard J.; Sachs, Francis L.; Clark, Willie E. (eds.). (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1971. 32p.

Twenty-two packages of engineering drawings and specifications are presented. Packages of drawings are included on solid-state alpha monitor/Q-2809A/; UF_6 sampling and storage facilities; TL neutron dosimeter; L-3 and L-10 shipping containers; criticality alarm system; Zeeman-modulated resonant cavity spectrometer; ultrasonics wideband amplifier; experimental mockup system for SNAP-23A; fueled prototype mockup system for SNAP-23A; bomb disposal transporter; advanced prototype system for SNAP-23A; silica-lavite furnace; thermal scanner; gel-filtration chromatographic apparatus; x-ray safety shutter; ultrasonic data acquisition system; shutter for rotating mirror framing camera; Model 10 shipping tube; criticality detector; computerized mass spectrometer auxiliaries; stirred reaction vessel; and analog data break interface. A subject index is included. (L.C.L.)

37525 (Y-NA-134) PERFORMANCE EVALUATION OF PRECISION NUMERICALLY CONTROLLED TURNING EQUIPMENT. Jones, F. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 30 Apr 1970. Contract W-7405-eng-26. 15p. (CONF-700958-1). Dep. NTIS.

From eleventh international machine tool design and research conference; Birmingham, England (14 Sep 1970).

The approach used at the Oak Ridge Y-12 plant for developing specifications for numerically controlled metal turning lathes and the methods used for evaluating the performance of such precision lathes are described. (L.C.L.)

37526 AN ELECTROMAGNETIC PUMP. Delisle, Jean-Paul; Le Frere, Jean-Paul (to Commissariat a l'Energie Atomique). French Patent 1,599,876. 20 Jul 1970. Filed 29 Nov 1968. (In French).

An invention is described which relates to an electromagnetic pump in which the tubes containing the circulating sodium are completely separated from other parts of the pump, such as the stator carrying the magnetic windings, the latter being indispensable to the working of the pump. An axial annular tube ensures the circulation of the liquid medium which is to be pumped. A magnetic tubular core, insulated from the liquid, is mounted inside the tube. A removable stator, cylindrical in form, encircles the outside of the tube. This comprises a rim, centralized with respect to a stop attached to a fixed plate, which supports the tube and extends perpendicularly to the axis of the tube. The plate is rigidly connected to the cylindrical guiding sleeve of the stator when the latter is being placed around the tube. The input and output pipes are placed at the same end of the stator. The pump may be of the horizontal or vertical type. (auth) (France)

37527 HIGH FREQUENCY FURNACES. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 95-7(Nov-Dec 1970). (In French).

High frequency induction furnaces allow high temperatures to be controlled in the presence of nuclear fluxes. Their technical characteristics and those of the sample-holders are given. The following applications are cited: diffusion of fission gases released by UO_2–UC-type fuels; and endurance or aging of graphite and UO_2 or UC fuels. (France)

37528 LOOP FOR STUDIES OF MASS TRANSFER AND RADIATION CORROSION OF GRAPHITE. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 151-2(Nov-Dec 1970). (In French).

The loop is used for the study of radiation induced chemical reaction kinetics in the moderator and coolant fluid of a natural U-graphite-carbon dioxide type power reactor. The main characteristics and components of the loop are presented. (France)

37529 LOOP FOR THE STUDY OF WEAR UNDER IRRADIATION. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 153-6(Nov-Dec 1970). (In French).

These loops are used for the study of graphite under irradiation. The protection of graphite and problems concerning the formation or destruction of the products produced were investigated by adding low concentrations of hydrogen, methane, carbon monoxide, or water vapor to the main gas. The loops consist of in-pile parts, regulating devices, and electrical control devices. The loops were irradiated in Siloe. (France)

37530 STUDY OF NONCONDENSABLE EFFECTS IN A HEAT PIPE. Colwell, G. T.; Williams, C. L.; Hsu, J. C.; Zevallos, G. E. (Georgia Inst. of Tech., Atlanta). Nucl. Technol.; 10: No. 3, 293-300(Mar 1971).

Experimental data are presented showing the effects of introducing argon into the vapor space of a water heat pipe under conditions of low to moderate heat transfer rates. At low heat transfer the presence of argon very greatly affected the thermal conductance of the heat pipe while at higher energy transfer rates the effects of the non-condensable were considerably diminished. Correlation equations are presented which take account of the effects of the presence of various quantities of non-condensable gas on heat pipe performance. (auth)

37531 INEXPENSIVE PUMP FOR LIQUID SODIUM. Schlueter, R. R.; Ruther, W. E. (Argonne National Lab., Ill.). Nucl. Technol.; 11: No. 2, 266-7(Jun 1971).

An inexpensive, commercially available linear actuator was modified to a small annular linear induction pump for sodium. Sodium temperatures <300°C may be conveniently pumped at pressures to 2 psi. The total cost, including a cooling fan, is less than $100. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 37530, 37672, 37918, 37919, and 38005.

37532 (AAEC/TM-580) CYCLIC HEAT TRANSFER AND STATIC PRESSURE DROP MEASUREMENTS ON PACKED BEDS. Mumme, I. A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1971. 23p. Dep. NTIS (U. S. Sales Only).

Using a cyclic temperature technique, average heat transfer coefficients were determined for gas flow through packed beds. Materials of widely differing thermal diffusivities were used, comprising, in turn, spheres of zircon sand, glass, steel and aluminium. The results agreed with data in the literature obtained by using a conventional heated sphere method. Pressure losses associated with flow of air through the beds were also measured, and the corresponding friction factors were evaluated for a considerable range of Reynolds numbers from 2,500 to 35,000. (auth) (Australia)

37533 (CONF-700557-2) SLIP FLOW IN ONE-DIMENSIONAL GAS CENTRIFUGES. Krause, E. Translated from Stroemungsmechanische Vorgaenge in Gaszentrifugen, DFVLR-Kolloquium, om 14, Mai 1970, Porz, Wahn, Germany. 9p. Dep. NTIS (U. S. Sales Only).

Approximate solutions are presented of equations of flow of compressible binary gas mixtures in one-dimensional gas centrifuges. The gas mixture is moved between two infinitely long coaxial cylinders. Assuming that the dependence of the transport coefficients on temperature and concentration can be neglected, the solutions are valid for continuum and slip ("Gleit") flow. Particular attention is given to the dependence of the separation factor on the peripheral velocity of the inner cylinder, the wall temperature and the Knudsen Number. (auth)

37534 (RT/ING-(70)27) HEAT EXCHANGE IN POST BURNOUT. I. THEORETICAL CONSIDERATIONS ON COOLING IN POST BURNOUT. II. DEPENDENCE OF HEAT EXCHANGE ON THE STATE OF TWO-PHASE MIXTURES IN THE POST-BURNOUT REGIME. Brevi, R.; Cumo, M. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). 12 Nov 1970. 62p. (In Italian). Dep. NTIS (U. S. Sales Only).

Some experimental results obtained at CISE are reported. These results refer to temperature measurement of heating wall cooled, under post burnout conditions, by a steam-water mixture flowing upwards in a tubular channel at 70 kg/cm^2 pressure and 220 g/cm^2 sec specific mass flow, the following conclusions arose from the study: in the post burnout the thermal flux φ is removed partly from the liquid phase (φ_l) and partly from the steam phase (φ_v): $\varphi = \varphi_l + \varphi_v$; the heat flux removed from steam is expressed by the product of the mixture-wall temperature stage and of an exchange coefficient which is a linear function of the quality; and the thermal flux removed by the liquid is directly proportional to the liquid quality. (auth)

37535 TRANSIENT DENSITY MEASUREMENTS IN TWO-PHASE FLOWS USING X-RAYS. Smith, A. V. (Atomic Weapons Research Establishment, Foulness, Eng.). J. Brit. Nucl. Energy Soc.; 10: 99-106(Apr 1971).

An x-ray attenuation method is described for the transient density measurement of water–steam mixtures. In the present application, these result from the rapid depressurization of water from maximum pressures and temperatures of 2500 lb/in.^{2} above atmospheric pressure and 636°F, respectively. Pipe sizes are 1.25 in. and 2.88 in. ID. Tests to check the response and accuracy of the system are described. These show that a step change from 0.60 to 0.45 in. of aluminum can be measured in 60 μs with a standard deviation error of 0.012 in. Assuming a homogeneous void distribution in the pipes the results show that void fraction can be measured with a standard deviation error of 0.02. (auth) (UK)

37536 DESIGN PRINCIPLES OF NUCLEAR HEAT SOURCES. Bortlik, J. Bull. EGU; 12: No. 3-4, 31-8(1970). (In Czech).

The use of nuclearly generated heat in centralized heat supply systems and a method for evaluating its advantages from the

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technological and economical point of view are analyzed. The project problems of whether to use a nuclear plant as a simple heat source or as a combined heat and power plant, determination of the turbine type, the correct value of the ratio of heat demand supplied by the turbine, and an optimal way of successive construction of a heat and power supply system with a basic nuclear source of energy are discussed. (auth)

Isotope Technology

Refer also to abstracts 37440, 37494, 37495, 37663, 37815, 37816, 37848, 38005, 38961, 39226, and 39322.

37537 (A/CONF.49/P-66) URANIUM ISOTOPE ENRICHMENT. Johnson, Wilfrid E. (Atomic Energy Commission, Washington, D. C.); Sapirie, S. R. (Oak Ridge Operations Office (AEC), Tenn.). Sep 1971. 14p. (CONF-710901-38). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

United States programs and policies designed to meet projected uranium-enrichment needs of domestic and foreign customers are discussed in a stepwise and comprehensive manner. The capabilities of present plants are described and future operating alternatives are analyzed against estimates of future requirements for enriched nuclear fuel. The effects of changes in various factors in the estimates of future nuclear-fuel needs and in the optimum mode for operation of the enrichment plants are discussed. Factors considered include plutonium recycle in thermal reactors, changes in enrichment-plant tails assay, changes in the cost of power or in the cost of uranium ore, and effects of advanced reactor technologies—including breeder reactors. Alternatives available for providing nuclear fuel for increased nuclear power capacity include increased power input to the diffusion plants, changing the tails assay, installation of equipment to upgrade the efficiency of power use within or beyond the present nominal power limit, and finally new plants. Estimates of the economic implications of these alternatives are summarized. Experience with the uranium-enrichment services agreement program since its inception in January 1969 is reviewed. Policy changes or considerations arising from the projected requirements for new large-scale investments in uranium-isotope enrichment capacity are discussed in terms of effects on new toll enrichment commitments. (L.C.L.)

37538 (A/CONF.49/P-840) RECENT ADVANCES IN APPLICATIONS OF ISOTOPES AND RADIATION IN THE UNITED STATES. Fowler, E. E. (Division of Isotopes Development (AEC), Washington, D. C.). Sep 1971. 19p. (CONF-710901-30). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

An overview is presented of recent developments in radioisotope and radiation technology in the U.S. with emphasis on areas of particular utility to developing nations. Growth in the quantity and variety of radioisotopes produced in the U.S. is discussed in relation to use trends. The topics discussed include: radioisotope production for medical diagnosis, research, and therapy; development of industrial nuclear measuring systems; development of equipment and methods for monitoring environmental pollution; and γ-source facilities for industrial radiation processing of materials and foodstuffs. Some of the factors which guide USAEC isotope development activities are reviewed. (L.C.L.)

37539 (CONF-700211-8) JAPAN'S POSITION IN URANIUM ENRICHMENT. Kikuchi, Seishi (Institute of Physical and Chemical Research, Tokyo (Japan)). [nd]. 2p. Dep. NTIS (U. S. Sales Only).

The enriched uranium requirements in Japan for nuclear power generation to the year 2000 are projected. It is concluded that there is an urgent need for Japan to have a 1000 ton/yr enrichment plant within the next ten years. (L.C.L.)

37540 (GA-8998) LIGHTWEIGHT, LOW-BALLISTIC COEFFICIENT, RADIOISOTOPE FUELED CAPSULE PROTOTYPE DEVELOPMENT PROGRAM. Final Report. Postula, F. D.; Elsner, N. B.; Emken, M. R. (Gulf General Atomic Co., San Diego, Calif.). May 1971. Contract AT(29-2)-2588. 191p. Dep. NTIS.

A program was completed for developing a capsule which would provide safe containment of a 700 W(t) radioisotope heat source using PuO_2 microsphere fuel. The final design is spherical, employs a tantalum alloy refractory structure and can readily be scaled over the power range from 500 to 1500 W(t). An extensive material evaluation testing program was undertaken to establish hafnia and pyrolitic carbon coatings for thermal protection and tungsten coatings for material compatibility. Prototype capsule tests were conducted to verify the design. These were: launch vibration simulation; solid propellant fire exposure tests; hyperthermal reentry simulation tests; subsonic drag drop tests; and rocket sled impact tests. All aspects of the capsule fabrication and assembly were developed based upon requirement for radioisotope fueling. Specific techniques were developed for: the hydroforming of components; assembly by electron beam welding tantalum alloy parts; and chemical vapor deposition and plasma spraying of protective coatings. (auth)

37541 (GA-8998(Suppl.B)) LIGHTWEIGHT, LOW-BALLISTIC COEFFICIENT, RADIOISOTOPE FUELED CAPSULE PROTOTYPE DEVELOPMENT PROGRAM. FINAL REPORT, SUPPLEMENT B. TEST DATA AND ANALYSIS. Postula, F. D.; Elsner, N. B.; Emken, M. R. (Gulf General Atomic Co., San Diego, Calif.). May 1971. Contract AT(29-2)-2588. 84p. Dep. NTIS.

Details are presented of tests which were conducted to evaluate the capsule reentry coating performance. A series of simulated reentry heating (hyperthermal) tests were completed in the Sandia high enthalpy arc tunnel using 4-inch diameter tantalum alloy spherical models. Two types of coatings were investigated: pyrolitic carbon and hafnia. These were applied in various thicknesses using various application techniques. After exposure to the simulated reentry environment, materials test specimens were cut from each model to evaluate the performance of the individual coating and application. These evaluations were done for two reentry conditions: launch abort and orbital reentry. The structural integrity of each model was maintained throughout each test. Hyperthermal tests were conducted on three 8-inch diameter capsules. Two instrumented capsules were tested to obtain data on the distribution of temperatures on the fuel container. One capsule had fuel container supports with radiation interchange ports while the other had supports without the ports. These results were compared with those predicted with the aerothermal computer model. A third 8-inch capsule was a prototype capsule which had been vibration tested and was impacted after reentry heating. Metallographic specimens were cut from the stagnation region of the 4-inch models. These were examined to evaluate the behavior of the W-CVD undercoat which protected the tantalum substrate. Physical data was compiled from available data on the ultimate tensile strength, yield strength and elongation characteristics of tantalum, T-111 and T-222 alloys. (auth)

37542 (NP-18809, pp 5.1-4) PRODUCTION AND APPLICATION OF RADIOISOTOPES. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

In Annual scientific report, 1969.

During 1969 the number of deliveries taken care of by the radioisotope department further increased, whereas the total activity showed a slight decrease. The engineering group designed and constructed several new facilities with the purpose of improving safety conditions and production efficiency. A new gamma irradiation facility loaded with 100,000 Ci of ^{60}Co became operational. The actinium program, based on the German-Belgian agreement between the Brown Boverie Co. and the Union Miniere, has as its objective the construction of a prototype thermoionic generator fueled with $^{227}Ac_2O_3$. The irradiation devices and hot cell facilities adapted for work with large quantities of ^{226}Ra and the resulting amounts of ^{227}Ac and ^{228}Th were completed and put into operation during the last quarter of 1969. The first irradiation took place in November and 112 mg of ^{227}Ac were produced and isolated. Routine production was started immediately thereafter. (auth)

37543 (NP-18809, pp 6.1-9) ACTINIUM PROGRAMME. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

In Annual scientific report, 1969.

The actinium program, based on the German-Belgian agreement between Brown Boverie Co. and the Union Minière, has as its objective the construction of a prototype thermoionic generator fueled with $^{227}Ac_2O_3$. The Belgian part of this program consists of the actinium production and the development of the isotopic heat source. The irradiation devices and hot cell facilities adapted for work with large quantities of ^{226}Ra and the resulting amounts of ^{227}Ac and ^{228}Th have been completed and put into operation during the last quarter of 1969. The first irradiation took place in November and 112 mg of ^{227}Ac were produced and isolated. Routine production was started immediately thereafter. Irradiation in BR2 of large quantities of radium required a special irradiation device consisting of an aluminum rig (thimble) connected to a suitably instrumented control panel. By irradiating the welded capsules in a thimble, a double containment is ensured and the risks of contaminating the coolant water of the primary cycle are negligible. The control panel is equipped with monitors checking the effluent air from the thimble for possible radon contamination. Three hot cells have been fitted out with chemical

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apparatuses for precipitation, ion exchange techniques, and handling of oxide powders. The irradiation targets are prepared in special encapsulating equipment which was shown to work satisfactorily. The radon adsorption facility has been successfully put into operation after extensive and thorough commissioning tests. The studies of fuel conditioning have been concentrated on the metallurgical characterization of a fuel concept based on either Ac_2O_3 coated with ThO_2 and W or a homogeneous mixture of $Ac_2O_3-ThO_2-W$ in the ratios 60:38:2. Extensive investigations were made on the preparation and properties of a ceramic plug which would allow helium (from α activity) to escape from the fuel matrix, without losing the gaseous decay products, which carry a substantial amount of energy. (auth)

37544 (NP-18893) COLLECTION OF ABSTRACTS ON IRRADIATION TECHNIQUES IN THE TEXTILE INDUSTRY. VOLUME II. Working Document No. 123. (European Atomic Energy Community, Brussels (Belgium). Bureau Eurisotop). 1970. 326p. (In several languages). Dep. NTIS (U. S. Sales Only).

Under a European Community project for promoting the use of isotopes and radiation in the textile industry, a collection of abstracts has been drawn up with the aid of Euratom's Centre for Information and Documentation (CID), together with contributions from textile organizations, firms and the participants in the project. (auth)

37545 (SC-DR-710218) STATUS REPORT. IMPACT TESTS: RADIOISOTOPE FUELS AND SIMULANTS. Dalby, W. J. (Sandia Labs., Albuquerque, N. Mex.). Apr 1971. 84p. Dep. NTIS.

The chronology is given of the impact testing of radioisotope fuels and simulants subsequent to the plasma-fired $^{238}PuO_2$ microsphere and samaria-tungsten cermet impact tests. Thirty-three individually encapsulated discs were impacted singly. The capsules were returned either to Battelle Memorial Institute, Columbus, or to Los Alamos Scientific Laboratory to be opened for particle size distribution determinations after impact. (auth)

37546 RADIOMETRIC DETERMINATION OF VELOCITIES FOR DIFFERENT SOLIDS IN THE PIPING SYSTEM OF A HYDRAULIC CONVEYING PLANT. Ehret, Rudolf (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.); Vogg, Hubert; Dedegil, Yavouz. VDI (Ver. Deut. Ing.) Z.; 113: 261-4(Mar 1971). (In German).

In the conveyance of mixtures of solids, water, and air through wells from depths down to 450 m the velocities of the solid particles (gravel, coal) were measured by means of sealed radioactive sources which are representative of the solid particles of the material conveyed. The uncertainty of the measurement by this method is about 5%. (auth)

37547 GAMMA RAY LASER. Piekenbrock, Lawrence J. (to Credo, Inc.). U. S. Patent 3,567,938. 2 Mar 1971. Filed 14 Feb 1968.

A coherent beam of gamma radiation is generated through stimulation of gamma transitions in excited atomic nuclei in a biologically shielded and low temperature closed resonating cavity. (auth)

37548 ISOTOPIC METHODS FOR THE ACCOMPLISHMENT OF THE RESEARCH PROGRAMS OF THE INTERNATIONAL HYDROLOGICAL DECENNIUM. Ferronskii, V. I. Isotopenpraxis; 6: 447-9(Dec 1970). (In German).

A survey is presented on the state and the possibilities of further development of the use of radioactive and stable isotopes as well as sealed radiation sources in hydrology and hydrogeology. (auth)

37549 LOW BALLISTIC COEFFICIENT RADIOISOTOPE HEAT SOURCE. Scheve, Martin R. (to Teledyne, Inc.). U. S. Patent 3,570,784. 16 Mar 1971. Filed 20 Oct 1967.

A radioisotope-containing heat source for use in artificial satellites and space vehicles is described. The source is configured so as to have a low ballistic coefficient allowing its random reentry into the earth's atmosphere at low terminal velocities. The low velocity prevents burnup and allows intact reentry of the radioisotopic fuel capsules. The heat source may typically be configured as a flat rectangular panel through which empty cylindrical channels are formed for lowering its weight and within which capsules containing the radioisotope are disposed. Graphite may be used to form the body of the panel. (Official Gazette)

37550 REENTRY PROTECTION FOR RADIOISOTOPE HEAT SOURCES. Bramer, S. E.; Lurie, H.; Smith, T. M. (TRW Systems, Redondo Beach, Calif.). Nucl. Technol.; 11: No. 2, 232-45(Jun 1971).

The basic safety requirement imposed on a radioisotope heat source is containment of the fuel under all normal and accident environments. A two-layer heat shield was designed to protect the radioisotope capsule during atmospheric reentry. Using 2- and 3-dimensional thermal models, parametric analyses were performed to compare the effectiveness of various insulative materials under simulated reentry conditions. It was found that a material able to insulate the capsule and at the same time distribute the heat quickly in the lateral directions will provide maximum thermal barrier capabilities. Such a material is the anisotropic pyrolytic graphite. The outer heat shield was designed to survive ablation, and thermal stress resulting from steep abort reentries. Numerous graphite materials were considered and were compared on the basis of their ability to withstand thermal stress, ability to be non-destructively tested, availability, and cost. AXF-5Q Poco graphite was superior in three of the selection categories and was selected. Design curves for ultimate tensile strength, strain to failure, modulus of elasticity, thermal expansion, and thermal conductivity were established and verified by destructive testing of samples of billets used. Nondestructive testing of the billets was performed to ascertain soundness. Ultrasonic pulse echo "c" scans and sound velocity traverses were performed and used to locate actual heat source components within the billets to contain the minimum number of defects possible. (auth)

37551 GENERATION OF A LOW-ENERGY POSITRON BEAM. Lohnert, Guenter H.; Schneider, Richard T. (Univ. of Florida, Gainesville). Nucl. Technol.; 10: No. 3, 315-21(Mar 1971).

A beam of slow positrons is required as a tool for a new plasma diagnostic technique. Other applications in particle physics and analytical chemistry exist, e.g., cross section measurements, analysis of trace elements, etc. Design and construction of a positron gun capable of generating a beam of slow positrons is described. Both ^{22}Na and ^{58}Co are possible positron sources. Employing a ^{22}Na source of 2 millicuries the device produces 1850 slow positrons per second, at a beam radius of 1.9 mm. (auth)

Materials Testing

Refer also to abstracts 37535, 37545, 37550, 37561, 37941, 37988, and 39219.

37552 SIGNIFICANCE OF QUALITY CONTROL FOR THE SERVICEABILITY OF NUCLEAR POWER PLANTS. Krueckemeier, Willi; Hantke, Hans-Juergen. At. Strom; 17: 7-11(Jan 1971). (In German).

Quality control of reactor vessels is accomplished by using non-destructive testing methods, preference being given to remote-controlled supersonic testing. The testing sensitivity needs to be adjusted in accordance with the technical testing conditions taking into account various kinds of defects. (auth)

37553 NEUTRON RADIOGRAPHY IN THE PR 10 TEST REACTOR AT THE AEG NUCLEAR ENERGY EXPERIMENTAL CENTER AT GROSSWELZHEIM. Mayer, Walter. Tech. Mitt. AEG-Telefunken; 60: 423-4(1970). (In German).

Neutron radiography represents a nondestructive test procedure. To obtain pictures on x-ray films, suitable converter foils are used such as gadolinium or dysprosium. Examples of typical applications are the detection of hydrogen-containing substances in metals, the measurement of fission product distribution in fuel elements, and the testing of radioactive objects. (H.B.G.)

37554 TESTING OF REACTOR VESSELS. Uebing, Dietrich; Meyer, Alfried. At. Strom; 17: 25-6(Jan 1971). (In German).

The safety of reactor vessels is co-determinant for the safety and availability of reactor equipment on the whole. Critical conditions of the material as well as defects and inhomogeneities of the elements may lead to such reductions of the availability and/or the annual operating time that the economic service is jeopardized by additional inspection and secondary safety measures. Planning and manufacturing of the pressure vessels need to be done with a view to reach a final quality so as to spare the repetitive testing or to reduce it to a minimum program of inspection. (auth)

37555 APPLICATION ON NON-DESTRUCTIVE TESTING METHODS WITH THE PERIODICAL INSPECTION OF REACTOR VESSELS. Trumpfheller, Rudolf. At. Strom; 17: 22-4(Jan 1971). (In German).

Periodic inspection of reactor vessels, in general, is only useful by means of nondestructive testing methods, preference being given to remote control ultrasonic testing. The testing sensitivity needs to be adjusted in accordance with the technical testing conditions taking into account all possible kinds of defects. (auth)

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37556 NONDESTRUCTIVE TESTING OF ENCAPSULATED RADIOACTIVE CESIUM AND STRONTIUM. Steffens, R. W. (Battelle-Northwest, Richland, Wash.); Crowe, J. C.; Borsheim, G. L.; Wormeli, J. C. Nucl. Technol.; 11: No. 2, 213-21(Jun 1971).

A nondestructive testing program is currently being developed at Battelle–Northwest, under the sponsorship of the Atlantic Richfield Hanford Company, to provide integrity assurance for waste capsules containing solidified radioactive cesium and strontium. Initiation of this project early in the design program for the waste capsules has permitted advanced nondestructive testing techniques to be included in the testing program. An ultrasonic inspection system has been developed and successfully tested in the laboratory using simulated specimens. Acoustic emission techniques, examined for potential use as a weld quality monitor, are promising but development is not yet complete. (auth)

Radioactive Material Handling

Refer also to abstracts 37269, 37305, 37556, 37618, 37700, 37796, 37826, 39226, 39240, and 39321.

37557 (A/CONF.49/P–61) SHIPMENT OF IRRADIATED POWER REACTOR FUELS IN THE UNITED STATES. Smith, C. W. (General Electric Co., San Jose, Calif.); Shappert, L. B. (Oak Ridge National Lab., Tenn.); Bush, F. J. Jr. (National Lead Co., Wilmington, Del.); Dufrane, K. H. (Nuclear Fuels Services, [Inc.], Rockville, Md.); Scaggs, R. A. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. [Savannah River Plant]). Sep 1971. 14p. (CONF-710901–10). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A rapid growth in the nuclear power industry in the U. S. is predicted between 1970 and 1980. This growth will result in a corresponding increase in volume of irradiated fuel (from 50 metric tons in 1970 to 3000 metric tons in 1980) which will have to be shipped and reprocessed. The principal problems involved in developing equipment and methods for transporting this amount of irradiated fuel are discussed, and include: providing the increasing detailed analysis required by the licensing authorities; improving cask operation and increasing cask effectiveness by performing additional test work in specific limiting areas; obtaining common carrier acceptance by all modes of transportation in all parts of the United States; assuring that adequate attention is given to the requirements for cask handling and operation at nuclear reactors and reprocessing plants; and maintaining the schedule required to design, license and fabricate the necessary shipping casks. (L.C.L.)

37558 (A/CONF.49/P–98) REVIEW OF THE GOALS, METHODS, AND TECHNIQUES OF NUCLEAR MATERIALS SAFEGUARDS. Kouts, H. J. C. (Brookhaven National Lab., Upton, N. Y.); Bennett, C. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.); Lawroski, S. (Argonne National Lab., Ill.). Sep 1971. 16p. (CONF-710901–43). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

An analysis of existing safeguards systems; the research and development, both present and future, needed to improve the present systems or provide equally effective alternatives; and the implications of the safeguards system with respect to the design and operation of nuclear facilities are discussed. Experience has indicated that safeguards research and development activities should concentrate on providing and improving methods of nondestructive assay for fissionable material. An area of recent emphasis is discussed, i.e., the significance of developing design criteria which will ensure that features important to good safeguards practices are included in the planning, construction, and operation of industrial nuclear facilities. (L.C.L.)

37559 (A/CONF.49/P–101) EXPERIENCE WITH A NUCLEAR MATERIALS INFORMATION SYSTEM. Haycock, T. J. Jr.; Weber, R. E. (Office of Safeguards and Materials Management (AEC), Washington, D. C.); Hyde, D. A. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Sep 1971. 11p. (CONF-710901–24). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The data-gathering functions and applications of the USAEC Nuclear Materials Information System (NMIS) are described. The system encompasses the activities of approximately 1200 entities. The central system is highly automated but is sufficiently flexible in its accumulation of information and production of usable reports to accommodate USAEC contractor data, commercial licensee data, and international data. The primary Computing Technology Center (CTC) computer system used is described. The sources and types of information input into the system and the data elements concerning them are discussed. Distinction is made between elements essential for safeguards alone, those for nuclear-materials management alone, and those common to both functions. A summary is presented of the many different types of reports presently generated by the NMIS and of how they serve many different aspects of materials management and safeguards. And, with a look to the future, the many new programs scheduled for NMIS are mentioned. (L.C.L.)

37560 (A/CONF.49/P–839) CURRENT DEVELOPMENTS IN LONG-TERM RADIOACTIVE WASTE MANAGEMENT. Culler, F. L.; Blomeke, J. O. (Oak Ridge National Lab., Tenn.); Belter, W. G. (Atomic Energy Commission, Washington, D. C.). Sep 1971. 16p. (CONF-710901–57). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The development of commercial nuclear power plants in the U. S. will create radioactive wastes which will require permanent disposal. The USAEC has promoted the development of processes for converting these liquid wastes to solid stable forms and the use of salt deposits as the final repository. A review is presented of the magnitude of the radioactive waste disposal problem, the characteristics of the wastes, the work that has been done to establish the suitability of bedded salt formations for their containment and which resulted in the successful field-scale experiment, Project Salt Vault, and the nature of the additional investigations which are either under way or scheduled to be done. (L.C.L.)

37561 (CONF-700211–6) PROBLEMS IN TRANSPORTATION OF SPENT FUEL. DEVELOPMENTAL TESTS ON TRANSPORTATION CASKS. Aoki, Shigefumi (Tokyo Inst. of Tech. (Japan)); Nakada, Seibei (Power Reactor and Nuclear Fuel Development Corp., [Tokyo]). [nd]. 7p. Dep. NTIS.

From Atomic Energy Society meeting; Tokyo, Japan (13 Feb 1970).

Equipment and methods developed in Japan for determining the safety of containers for shipping spent fuel elements are described. (L.C.L.)

37562 (NP–18809, pp 4.1-6) SAFETY STUDIES. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

In Annual scientific report, 1969.

Work was pursued on the radiophysical control of the environment, such as radioactive fallout in Belgium, along the lines of national and international recommendations, and on the alimentary chain. Work was performed on atmospheric diffusion in general, and particularly for the Tihange site where a nuclear power plant will be built. Detection methods of nuclides in biological samples were further improved. Waste disposal studies of liquid waste concentration processes on inorganic ion exchangers were pursued. The program with respect to the control of materials under safeguards, which began in 1968, took shape. (auth)

37563 (ORNL-TM-3403) ANALYSIS OF ENERGY STORAGE AND ITS EFFECTS IN THE PROPOSED NATIONAL RADIOACTIVE WASTE REPOSITORY. Blomeke, J. O.; Sonder, E.; Nichols, J. P.; Lindenbaum, S.; Dillon, R. S.; Arnold, E. D.; Soard, H. F. (Oak Ridge National Lab., Tenn.). Jun 1971. Contract W-7405-eng-26. 39p. Dep. NTIS.

Energy stored in solids as a consequence of radiation damage within crystal lattices may be released as this damage is annealed at higher temperatures. Based both on theoretical considerations and experimental measurements, the quantity of energy which could be stored in the proposed salt mine repository is small. Analyses based on upper-limit values of stored energy show that its release under the most pessimistic conditions would have no serious consequences. Some additional work is required, however, to establish actual values for energy storage in the salt and solidified wastes under the transient thermal and radiation conditions that will prevail in the repository. (auth)

37564 (STI/PUB–283) DISPOSAL OF RADIOACTIVE WASTES INTO RIVERS, LAKES, AND ESTUARIES. Safety Series No. 36. Report of a Panel of Experts. (International Atomic Energy Agency, Vienna (Austria)). 1971. 85p. IAEA $3.00.

Principles and practices are presented which, if applied to the disposal of radioactive wastes into inland surface and estuarial waters, will ensure that man will not experience radiation exposures that are above the limits recommended by the International Commission for Radiation Protection (ICRP); and further, that radiation exposure is kept as far below those limits as is practicable. The mechanisms and parameters which affect and control the fate of radionuclides introduced into fresh waters are described. The concepts of "critical nuclide", "critical pathway", and "critical population group" are discussed, and the use of these

concepts to provide a sound, convenient, and economical means for setting discharge limits and maintaining continuing surveillance is demonstrated. Information on uptake and dispersion mechanisms is presented, and methods for estimating potential radiation doses and for establishing discharge limits are described. (L.C.L.)

37565 PLUTONIUM: REACTOR PROLIFERATION THREATENS A NUCLEAR BLACK MARKET. Shapley, Deborah. Science; 172: 143-6(9 Apr 1971).

Plutonium, which will be produced in ever increasing quantities by the growing number of commercial power reactors predicted to be in operation by the 1980's, poses a major safeguards problem. The possibilities of a worldwide black market in enriched Pu, the significance of this to the illicit building of atomic bombs, and the particular theft hazards inherent in the commercial transport of Pu are discussed. (L.C.L.)

37566 SAFEGUARDS: WITH OR WITHOUT STRINGS? Barnaby, Frank. Sci. Sci. J.; 49: 430-2(25 Feb 1971).

Within the next year, the 70 or so non-nuclear weapon countries who have ratified the nonproliferation treaty will have to negotiate safeguards agreements with the International Atomic Energy Agency to verify compliance with their obligations under the treaty. For the sake of other international arms control measures, such as the recent treaty prohibiting the emplacement of nuclear weapons on the sea-bed, no State should be seen to have more favorable treatment than the others in the applications of the verification process. (auth) (UK)

37567 PROBLEMS OF RADIOIODINE IN NUCLEAR POWER PLANTS. Hladky, E. Bull. EGU; 12: No. 3-4, 39-47(1970). (In Czech).

It is possible to divide the problems of radioiodine in nuclear plants into four main categories: the mechanism of radioiodine release and forms of its existence; the study of convenient adsorbents for removing radioiodine; the questions concerning the transport behavior of radioiodine; and utilization of its detection for dosimetric control and for the purpose of radiation safety of nuclear facilities and surroundings. Basic knowledge about these problems, the extent of the problems, and their importance in the safe operation of nuclear power plants are summarized. (auth)

37568 SOLIDIFICATION OF RADIOACTIVE WASTES. A NEW APPLICATION OF BITUMENS. Maczynski, M.; Ksiazak, Z. Gaz, Woda Tech. Sanit.; 44: 208-12(1970). (In Polish).

A new method applicable to the solidification of radioactive wastes is described. Advantages of this method are given in comparison with the cementation and vitrification processing for solidification of radioactive wastes. The domestic bituminous materials suitable to this purpose are also discussed. Finally, effects of several factors on the properties of the final product under long-term ground storage are given. (auth) (NSA of Poland)

37569 . CODE OF PRACTICE FOR THE STORAGE OF RADIOACTIVE MATERIAL IN TRANSIT. London; Her Majesty's Stationery Office (1970). 21p. £ 0.20. (NP-18761).

This Code of Practice is intended to assist those who may be responsible for the temporary storage or warehousing of radioactive material which is in transit and not on the premises of the consignor or the consignee of the material. It is recommended to those responsible as a guide by which to determine their practice in order to avoid the risk of over-exposure to radiation of persons and damage to goods of other parties. The Code conforms generally to recommendations made by the International Atomic Energy Agency and has been approved by the Radioactive Substances Advisory Committee. (UK)

37570 MULTI-SPECTRA NEUTRON IRRADIATION TECHNIQUE FOR THE NONDESTRUCTIVE ASSAY OF FISSIONABLE MATERIALS. Menlove, H. O.; Augustson, R. H.; Smith, Darryl B. (Los Alamos Scientific Lab., N. Mex.). Nucl. Technol.; 10: No. 3, 366-79(Mar 1971).

A technique has been developed for the nondestructive assay of fissionable materials which makes use of the fission cross section energy variations for a given isotope in order to produce a signature characteristic of that isotope. The technique consists of irradiating the sample with neutrons from an accelerator and measuring the delayed-neutron response from the induced fission reactions in the sample. Different neutron irradiation energies were obtained by surrounding a 14-MeV neutron source with various moderating assemblies. Assay results obtained using this delayed-neutron technique include the following: (1) uranium samples with enrichments ranging from ~3 to 98%; (2) plutonium–uranium oxides; (3) $^{233}U-^{232}Th$ salt mixtures; (4) "spent" reactor fuel elements; and (5) scrap containers ranging in size from small vials to one-gallon cans containing plutonium or uranium scrap. In addition, measurements have been made on the influence of various nonfissionable matrix materials on the assay results. (auth)

Vacuum Engineering

Refer also to abstracts 37686 and 37926.

37571 LEAK DETECTION IN VACUUM SYSTEMS BY A FLUORESCENCE TECHNIQUE. Winge, Royce K. (Ames Lab., Iowa). J. Vac. Sci. Technol.; 7: 610-11(Nov-Dec 1970).

Experiments showed that an anthracene-saturated acetone solution can detect and locate leaks of less than 10^{-5} torr-liter/sec in weld joints. The anthracene fluorescence was excited by a mercury lamp with an uv-transmitting filter. The anthracene did not interfere with subsequent welding by inert-gas arc, although a second pass was required if an electron beam was used. (D.L.C.)

37572 SORPTION AND ION-GETTER PUMPING FOR A SLIDING-SHAFT VACUUM LOCK. Stoffels, J. J. (Battelle-Northwest, Richland, Wash.). J. Vac. Sci. Technol.; 7: 606-7 (Nov-Dec 1970).

The sliding-shaft vacuum lock is used to change solid samples in surface-ionization mass spectrometers used for isotopic analysis of U. Contamination by back streaming oil vapors from the pumps was occurring in one design, and sorption and ion-getter pumps were used in the new design to handle the dynamic gas load in order to eliminate this source of contamination. A static O-ring seal is provided at the atmosphere end of the vacuum lock in order to permit rejuvenation of the sorption pumps without loss of vacuum. The maximum period of continuous operation is probably over a week. (D.L.C.)

37573 APPARATUS FOR ULTRAHIGH-VACUUM IN SITU THIN-FILM STUDIES. Chase, Wayne R. (Systems Research Labs., Dayton, Ohio); Prell, Raymond A.; Ruf, Franz X. J. Vac. Sci. Technol.; 7: 607-10(Nov-Dec 1970).

A detailed description is given of an apparatus developed for fabrication of thin-film devices under ultrahigh vacuum and in situ measurement of such surface properties as photoemission, optical absorption, electric characteristics, etc. In this 15-cm dia apparatus, fabrication, surface treatments, and measurements can be done without removing the sample from vacuum. Design and operation of the substrate-transport carts, masking-indexing mechanisms, and shutter mechanisms are described. (D.L.C.)

37574 PROCEEDINGS OF THE SECOND INTERNATIONAL VACUUM METALLURGY CONFERENCE, HELD AT ANAHEIM, CALIFORNIA, 15–19 JUNE 1970. J. Vac. Sci. Technol.: 7: S1-168(Nov-Dec 1970). (CONF-700640).

Twenty-six papers and 12 abstracts are included. Among the topics treated are: metal reactions with gases, fabrication techniques, heat treatments, superconductors, purification, degassing, etc. An author index is also included. Separate abstracts have been prepared for eleven of the papers. (D.L.C.)

For abstracts of individual papers see: 37925–37927, 37934–37937, 37952, 38011, 38312, and 38313.

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INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 37837 and 38630.

General Detectors and Monitors

Refer also to abstracts 37713, 37746, 37769, 37811, 37827, 38940, 38943, 39145, 39147, 39160, 39258, 39260, and 39304.

37575 (BARC-548) WHOLE BODY COUNTING OF RADIATION WORKERS. Hukkoo, R. K.; Katoch, D. S. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 18p. Dep. NTIS (U. S. Sales Only).

As part of the personnel monitoring program, a shadow shield whole-body counter is used to carry out the routine measurements of total body activity of radiation workers at Trombay. The shield is specially designed to use a minimum amount of shield material for a given effective shielding and results in background counting rates comparable with steel room monitors. Data are presented on the performance characteristics of the counter and its use in single crystal multiple position counting geometry to study the changing pattern of distribution of radon daughter products along the longitudinal axis of the body of a control subject exposed to uranium mine atmosphere. (auth)

37576 (CEA-N-1417) RAPID CONTAMINATION SIGNALING SYSTEM. Chaud, Andre; Da Costa Vieira, David; Friedling, Georges; Suzan, Henri; Vieuxmaire, Claude (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Dec 1970. 29p. (In French). Dep. NTIS (U. S. Sales Only).

A device that enables the selection of an effective signal of accidental contamination among parasite signals of natural contamination even if it is of low intensity is described. The principle used is a numerical filtering method according to the following formula: $a_t = a_{t-1} + \alpha\ (x_t - a_{t-1})$. In this formula, the new a_t filter output at the t time is computed from the a_{t-1} last output at the $t-1$ time, to which a corrective term proportional to the difference between the new x_t input and the a_{t-1} last output is added. The appearance of an accidental contamination is reported when the $x - a_{t-1}$ difference exceeds a predetermined threshold. This device comprises an analog part which enables a normal monitoring of natural contamination. Designed for a 16 channel maximum capacity, the device has rather small dimensions: 5U standard frame. (auth) (France)

37577 (CEA-R-4195) NUCLEAR HEATING MEASUREMENTS USING IONIZATION CHAMBERS. De Cosnac, Bertrand; Delacour, Jean; Fiche, Charles; Noel, Jean-Paul; Lott, Michel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1971. 56p. (In French). Dep. NTIS (U. S. Sales Only).

The use of ionization chambers to measure nuclear heating effects is described. The basic principles of ionization chambers are recalled, and various experiments for determining their sensitivities to different radiations are described. Examples are given of practical developments illustrating the flexibility of the technique. The method of calibration is also described. (auth)

37578 (KFKI-71-13) CONTINUOUS MEASUREMENT OF THE ACTIVITY CONCENTRATION OF RADIOIODINE IN AIR. Molnar, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Mar 1971. 16p. Dep. NTIS (U. S. Sales Only).

An automatic instrument for the continuous measurement of the activity concentration of radioiodine in the air is described. The air is sampled by a band of Wattmann's ACG/B filter material driven at a constant but variable speed. A NaI(Tl) crystal is used as detector. By calibration with a ^{131}I standard, the instrument was found to have a measuring range of 10^{-10} to 10^{-6} Ci/m^3 and a sensitivity of 150 (cpm $\cdot$ m^3/nCi). The results of investigations with the device on the ventilation system of an experimental reactor are reported. (auth)

37579 (LA-tr-71-40) SYMMETRY DEFECTS IN THE MEASUREMENT OF POLARIZATION. II. INFLUENCE OF INSTRUMENTAL SYMMETRY DEFECTS IN THE CASE OF THE USUAL METHODS OF MEASURING POLARIZATION. Libert, J. Translated for Los Alamos Scientific Lab., N. Mex., from Nucl. Instrum. Methods; 44: 188-98(1966). 31p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 43698.

37580 (LA-tr-71-41) SYMMETRY DEFECTS IN THE MEASUREMENT OF POLARIZATION. III. DISCUSSION OF THE INFLUENCE OF INSTRUMENTAL SYMMETRY. DEFECTS IN THE CASE OF THE USUAL METHODS OF MEASURING POLARIZATION. Libert, J. Translated for Los Alamos Scientific Labs., N. Mex., from Nucl. Instrum. Methods; 44: 199-207(1966). 27p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 43699.

37581 (NP-18875) RESPONSE OF LIQUID IONIZATION CHAMBERS TO PULSED PHOTON AND ELECTRON BEAMS. INHIBITION OF THE IONIZATION CURRENT BY ELECTRONEGATIVE COMPOUNDS. Grob, Robert (Toulouse Univ. (France). Faculte des Sciences). 1971. 101p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The ionization produced in certain dielectric liquids, particularly alkanes, by γ radiation from ^{60}Co and the inhibition of this ionization by electron scavengers were investigated. Values for $G_{(0)}$ i.z (free ions produced at zero field per 100 eV absorbed) and for parameters concerning the mean thermalization b, were calculated using Onsager theory. These parameters explain the inhibition phenomena and can be used to introduce an electronegativity classification for the scavenger products used, similar to classical chemical notation. A difference was observed between the behavior of alkanes and benzene. Values for W (energy necessary to create an ion pair in the dielectric) are discussed. The collection efficiency f for ionization chambers (filled with these dielectric liquids) was investigated using pulsed or continuous beams (photons or electrons). It is shown that for a short intense pulse $f = \log (I + U)$, according to the Boag formula. Formulas for dealing with all the possible cases are mentioned. The ionization due to a monoenergetic 32 MeV electron beam was measured as a function of depth in a Plexiglass phantom. Liquid ionization chambers were particularly useful in measuring the surface yield. (France)

37582 (NP-18898) DEVELOPMENT AND STUDY OF MULTIPLE ANODE HALOGEN GEIGER-MUELLER COUNTERS. Sekhavat, Ali (Toulouse Univ. (France). Faculte des Sciences). 1970. 79p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A substantial improvement of the halogen Geiger-Muller counter properties was carried out by studying new anode forms. This amelioration was revealed by the comparison of the new counters with the classical ones, absolutely identical is size and production, only the anodes being different. (France)

37583 (UCRL-51011) SEMICONDUCTOR DETECTORS FOR USE IN THE CURRENT MODE. Kuckuck, Robert W. (California Univ., Livermore. Lawrence Radiation Lab.). 10 Feb 1971. Contract W-7405-eng-48. 67p. Dep. NTIS.

Topics include descriptions of typical current-mode detectors, response to radiations-theory and experiment, time response, linearity-dynamic range, field applications, and environmental and damage considerations. (W.H.K.)

37584 LOW LEVEL COUNTING OF TRITIUM USING PROPORTIONAL COUNTER. Povinec, P.; Chudy, M.; Seliga, M.; Saro, S. (Comenius Univ., Bratislava). Isotopenpraxis; 7: No. 2, 54-7(Feb 1971).

A proportional counter for measurement of low tritium activities is described and its characteristics are discussed. Two gas fillings have been used. With dead methane and hydrogen (50%) mixture the minimum detectable activity which could be determined after 24 hours of counting with 10% accuracy is 450 TU. Using ethane gas filling the minimum detectable activity is 50 TU. (auth)

37585 POSITRON CAMERA WITH MULTIPLANE FOCUSING. Anger, Hal O. (to United States Atomic Energy Commission). U. S. Patent 3,573,458. 6 Apr 1971. Filed 27 Mar 1969.

A positron radiation detecting camera for obtaining, in one step, an image of the distribution of radioactivity at several different depths in a living subject is described. Several views are simultaneously presented, each view being focused at a differing plane in the subject between the image detector and focal detectors of the camera. Thus, it is not necessary to know in advance from which plane the radioactivity will emanate, since at least one image will be in focus. Also, radioactivity may emanate from several planes simultaneously. The radiation is detected as in the prior known single-plane positron camera but positional information is electronically combined in differing ratios to obtain multiplane focusing. (auth)

37586 RATEMETER WITH AUTOMATIC DEAD-TIME CORRECTION. Metz, Arthur J.; Howard, Robert H. (to United States Atomic Energy Commission). U. S. Patent 3,573,639. 6 Apr 1971. Filed 4 Dec 1969.

A pulse rate meter receiving from a signal handling system having a variable dead time during a time T a train of random pulses having varying pulse widths includes a first circuit for producing an output signal whose amplitude is proportional to the ratio of the summed time intervals between pulses in the train of random pulses and the time T, a second circuit for producing, responsive to each random pulse, an output pulse whose width is inversely proportional to the output signal of the first circuit, and a third circuit for integrating the output pulses of the second circuit to produce a rate meter output which is representative of the true pulse rate input to the signal handling system. (auth)

37587 SYSTEM FOR MEASURING A PULSE CHARGE. Porat, Dan I.; Anderson, Robert L. (to United States Atomic Energy Commission). U. S. Patent 3,573,615. 6 Apr 1971. Filed 14 Sep 1967.

A circuit operable in response to a low-power nanosecond input pulse for developing an output pulse having a peak voltage proportional to the total charge of the input pulse is described. The input pulse is applied through a normally conducting transistor to a storage capacitor, which is discharged through a resistor to drive an amplifier over a decay period on the order of 50 times the period of the input pulse. The amplifier output pulse is applied to a second storage capacitor and discharge resistor circuit to produce an output pulse that has a rise time equal to the input pulse period plus the decay period of the first storage circuit and a fall time equal to the decay period of the second storage circuit. The circuit is designed for a scintillation detector. (auth)

37588 SYSTEM FOR RECORDING THE ^{12}B ISOTOPE WHICH IS FORMED ACCORDING TO THE $^{12}C(n,p)$ REACTION. Tustanovskii, V. T.; Andryushchenko, V. I.; Vol'gemut, A. A. At. Energ. (USSR); 29: No. 2, 119-20(Aug 1970) as paper No. 412/5713.

A scintillation detector system for detecting the beta particle emitted in the decay of ^{12}B formed in the neutron activation of C is discussed. A block diagram is given for the circuit described. A signal-to-background ratio of nearly 8 to 1 was obtained in an experiment on graphite. A value of 19.2 ± 0.38 msec was obtained for the half-life of ^{12}B. (R.W.R.)

37589 LOW PRESSURE MULTIWIRE PROPORTIONAL CHAMBERS WITH HIGH TIME RESOLUTION FOR STRONGLY IONIZING PARTICLES. Binon, F. (IISN, Brussels); Bobyr, V. V.; Duteil, P.; (and others). Nucl. Instrum. Methods; 94: No. 1, 27-8(1971).

Multiwire proportional chambers have been tested in the range of pressures from 3 to 30 mm Hg with isobutane, pentane and heptane. With 5.5 MeV α particles, a time resolution of 2.5 nsec was obtained at 100% efficiency. (auth)

37590 64000 CHANNEL 2 PARAMETER PULSE HEIGHT ANALYZER FOR COINCIDENCE STUDIES. Pohl, K. P.; Manning, M. R. (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). Nucl. Instrum. Methods; 94: No. 1, 23-5(1971).

Modifications enabling a dual ADC (ND160F) operating into a small computer with disc storage (PDP-8) to be used as a low count rate multi-channel analyzer are described. (auth)

37591 MULTIPLEX SWITCH FOR MULTIDETECTOR EXPERIMENTS. Boepple, K.; Brendle, M. (Univ., Tuebingen, Ger.). Nucl. Instrum. Methods; 94: No. 1, 7-12(1971).

A multiplex switch and the associated control logic to be used with 8-detector 3-parameter experiments is described. The distortion of the distribution of the events from different detectors due to the multiplex switch control is discussed. (auth)

37592 FAST COINCIDENCE SYSTEM FOR SEMICONDUCTOR DETECTORS. Nainan, T. D. (Virginia Polytechnic Inst., State Univ., Blacksburg, Va.). Nucl. Instrum. Methods; 94: No. 1, 1-5(1971).

A coincidence system has been designed for use with semiconductor detectors. Its resolving power was calculated assuming certain distribution functions for the pulse shape; and compared to the measured values using two different time-to-amplitude converters. Its performance was tested with radioactive sources of known decay schemes. (auth)

37593 NEW TECHNIQUE FOR OBTAINING (p,n) ANGULAR DISTRIBUTIONS. Woods, T. J.; Igo, G. J.; Sunier, J. W.; (and others) (Univ. of California, Los Angeles). Nucl. Instrum. Methods; 94: No. 1, 87-92(1971).

A somewhat novel technique has been developed to obtain angular distributions for (p,n) reactions populating isobaric analog states (IAS) when they decay by proton emission ($\tilde{p}$). It entails obtaining neutron time-of-flight spectra measured relative to $\tilde{p}$ events rather than to the periodic structure of the beam. This technique is found to significantly simplify experimental arrangements for time-of-flight measurements. (auth)

37594 NEUTRON THERMOMETERS. Eichholz, G. G. (Georgia Inst. of Tech., Atlanta). Nucl. Instrum. Methods; 94: No. 1, 131-5(1971).

Reactor monitoring of power reactors requires indicators capable of functioning in a high-flux radiation environment. Nitride materials appear suitable as neutron thermometers, through the use of the $^{14}N(n,p)^{14}C$ reaction. Silicon nitride has been tested, bonded to a chromel-alumel thermocouple, as a flux indicator and appears to be superior to other nitrides tested. Tests have been conducted in neutron fluxes of the order of 2×10^{12} n/cm^2-sec. No changes in performances were observed after cumulative exposure to an nvt value of 9.5×10^{18} n/cm^2. (auth)

37595 NEUTRON DETECTION EFFICIENCY OF THE LIQUID SCINTILLATOR NE 214 IN THE MeV RANGE. Kellermann, H. J.; Langkau, R. (Univ., Hamburg). Nucl. Instrum. Methods; 94: No. 1, 137-40(1971).

The neutron detection efficiency of the liquid scintillator NE 214 intended for use in a fast neutron time-of-flight spectrometer was investigated for incident neutron energies between 0 and 15 MeV. The measurements were performed by various techniques. A Monte Carlo method was used for calculations. (auth)

37596 PULSE RISETIME ANALYSIS OF A ^3He PROPORTIONAL COUNTER. Izumi, S. (Atomic Energy Research Lab., Kawasaki, Japan); Murata, Y. Nucl. Instrum. Methods; 94: No. 1, 141-5(1971).

Pulse height and risetime distributions of signals from a ^3He proportional counter have been investigated to discriminate undesirable signals arising from the ^3He recoil and wall effect. The risetimes of the wall effect suffered pulses are distributed in the slower region and that of the recoiled helium atoms, in the faster and narrow region in comparison with that of the $^3He(n,p)T$ reaction. One can distinguish the full energy signal from the undesirable ones by appropriate risetime selection. Anisotropy of the pulse height and risetime distribution was also measured for the parallel and vertical neutrons incident to the counter axis. (auth)

37597 MEASUREMENTS OF THE FANO FACTOR IN GERMANIUM. Strokan, N. (Ioffe Inst. of Physics and Tech., Leningrad); Ajdacic, V.; Lalovic, B. Nucl. Instrum. Methods; 94: No. 1, 147-9(1971).

For two Ge(Li) detectors of 15 cm^3 and 40 cm^3 contributions of different factors to the detector resolution were measured and the Fano factor was derived by using $\delta^2 = \delta^2_{ion} + \delta^2_{col} + \delta^2_{noise}$ relation for the square of energy resolution and linear extrapolation of δ^2 for the infinite field strength from the dependance of δ^2 on the reciprocal detector voltage. The Fano factor in germanium has been found to be F = 0.058 ± 0.011. (auth)

37598 VARIATION OF THE INTRINSIC EFFICIENCY OF A CYLINDRICAL PLANAR Ge(Li) GAMMA-RAY DETECTOR WITH SOURCE DISTANCE. Smith, D. L. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 94: No. 1, 157-63(1971).

The relative full-energy peak efficiency of a cylindrical planar Ge(Li) gamma-ray detector deviates considerably from r^{-2} behavior when the distance r from the front face of the detector to a localized source of radiation approaches the order of the dimensions of the detector. The measured deviations have been observed to agree quite well with predictions of simple formulae derived. (auth)

37599 GEOMETRICAL FACTOR DETERMINATION USING A MONTE CARLO APPROACH. Crannell, C. J. (Catholic Univ. of America, Washington, D. C.); Ormes, J. F. Nucl. Instrum. Methods; 94: No. 1, 179-83(1971).

A Monte Carlo technique is employed to compute the geometrical factor, path-length spectra, and zenith angle distributions for a variety of detector configurations. An incident flux is simulated by choosing four initial parameters for each of a large number of events according to the appropriate probability distributions. The resultant paths are individually tested to determine the exit plane from the detector and the path length within the detector. The desired data are tabulated by summing over numerous simulated events. The flexibility, speed, and accuracy achieved with this technique make it extremely useful for evaluating detector designs with simple or relatively complicated geometry. (auth)

37600 SOLID ANGLE SUBTENDED AT A DISK SOURCE BY A NON-PARALLEL DISK DETECTOR. Oblozinsky, P.;

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Ribansky, I. (Inst. of Physics, Bratislava). Nucl. Instrum. Methods; 94: No. 1, 187-8(1971).

An integral formulation of the solid angle for the general disk–disk arrangement is presented. Simple programming is possible and short computer time is needed. (auth)

37601 PARTICLE DETECTOR. Lansiart, Alain; Leloup, Jean; Lequais, Jean (to Commissariat a l'Energie Atomique). British Patent 1,227,515. 7 Apr 1971. Priority date 26 Feb 1968, France.

An ionization detector for beta particles and x- or γ-ray photons is described; in particular, use of a mixture of diethylamine and xenon as a filling gas permits operation at a lower electric field than previously possible. (R.W.R.)

37602 RADIOLUMINESCENCE DECAY OF ORGANIC SCINTILLATORS. Voltz, R.; Walter, G.; Laustriat, G. (CNRS, Strasbourg). pp 169-85 of Comptes Rendus du 92e Congres National des Societes Savantes. Tome 2. Paris; Bibliotheque Nationale (1970). (In French).

From ninety-second national congress of the Learned Societies; Strasbourg, France (31 Mar 1967). See CONF-670342-(Vol. 2).

The principal results obtained on the radioluminescence decay of fluorescent organic substances (single crystals, liquids, and plastics) are presented. A theoretical analysis of the primary processes generated in these substances by the charged particles enabled the establishment of the variations in intensity of the scintillations as a function of time. It is shown that the relations developed are in good agreement with experimental results obtained with equipment capable of reproducing decay curves of very short time duration (some nanoseconds). A method of discriminating different types of particle based on observing the intensity variations of the slow component is indicated. (auth) (France)

37603 PLANE POLARIZATION OF GAMMA RADIATIONS. Knipper, Albert (Univ., Strasbourg). pp 213-26 of Comptes Rendus du 92e Congres National des Societes Savantes. Tome 2. Paris; Bibliotheque Nationale (1970). (In French).

From ninety-second national congress of the Learned Societies; Strasbourg, France (31 Mar 1967). See CONF-670342-(Vol. 2).

If the angular momentum L, and its projection M, of an electromagnetic radiation are defined, then the radiation is polarized. Methods of nuclear alignment enabling the observation of partially polarized radiation are discussed. The angular intensity distribution function and the plane polarization distribution function are obtained from a general angular correlation formalism. The definition of the polarization p explains the method adopted for the polarization distribution analysis. The product pW (θ) depends only upon the angular momentum of the levels connected by the electromagnetic transition, the parity of the radiation and the mixing coefficients of the multipolar waves. The polarimeter consists of a counter, diffuser and two analyzers (one in the emission plane and the other perpendicular to it) and is based on the asymmetric Compton scattering of the polarized radiation. The methods used to calibrate the polarimeter are indicated and several recent experiments described. (auth) (France)

37604 PARTICLE DETECTOR. Lansiart, Alain (to Commissariat a l'Energie Atomique). French Patent 1,401,288. 6 Jul 1970. Filed 1 Aug 1968. 2nd Addition 95,282. (In French).

Improvements to a multiwire spark chamber designed for rendering the impact of beta particles and X or gamma ray photons visible, are described. A new technique is proposed which enables the dead time of the detector to be reduced. The anode is made of several electrically isolated elements of equal areas each connected to the anode of the high voltage supply through a high resistor. The resistances connecting the anode elements to the high voltage supply are equal. (France)

37605 CLINICAL APPLICATION OF CLINICAL DATA SYSTEM, CDS-4096 INTO THE FIELD OF NUCLEAR MEDICINE. Kojima, Kazuhiko; Hisada, Kin-ichi (Kanazawa Univ., Japan). Radioisotopes (Tokyo); 20: No. 6, 266-72(Jun 1971). (In Japanese).

Scintigraphy is used widely to examine radioactivity distribution within the body, but the image itself is not sharply delineated because of the statistical fluctuation of radioactivity and the limitation of the resolution of the detector. Use of a computer for the purpose of image correction will increase the diagnostic accuracy due to scintigraphy and therefore expand the diagnostic field based on scintigraphy. During operation of the medical data system CDS-4096 coupled with scinticamera (PHO-GAMMA III) from March, 1970, various on-line processing routines were studied. This system was capable of operating conveniently many functions of variable threshold, digital smoothing and many others as image processing, transit time activity histogram and profile histogram. Furthermore, by processing repeatedly under visual control, the best result could be obtained at real time. Thus, information representing the concentration of activity in selected organs or anatomical areas of interest was shown as digital data in detail, and the characterization of lesions and functional abnormalities was obviously improved by data display formats. Also, comparing with the case of using another minicomputer, the system (the wired program computer) could use all memory (4,096 channels) in it as an image matrix and the processing time was rapid. In addition, considering the relation between memory capacity and the resolution of the system, the optimum memory capacity of the system is discussed. It was decided that the data memory capacity of the system with CRT display (8 cm × 8 cm) might be desired to have 8 K core memory at least and about 20 K core memory if possible. (auth)

37606 SYSTEM FOR MEASURING PULSED RADIATION BY MEANS OF STRAIN GAUGE TECHNIQUE. Binder, Daniel; Peffley, Williard M. (to Secretary of the Navy). U. S. Patent 3,569,707. 9 Mar 1971. Filed 7 Apr 1967.

A system for measuring the energy absorbed by a material subject to pulsed nuclear radiation by detecting the thermal expansion of the material with strain gauge techniques is described. (auth)

37607 $\beta-\gamma$-COINCIDENCE MEASURING DEVICE WITH A SIMPLE SCINTILLATION-DETECTOR SYSTEM FOR ABSOLUTE ACTIVITY MEASUREMENT. Schoenfeld, E. Isotopenpraxis; 6: 452-6(Dec 1970). (In German).

Description is supplied of the beta–gamma-coincidence measuring device preferably used by DAMW for the determination of the disintegration rate of activated gold foil. Its detector system consists of a plastic scintillator and a NaI(Tl) crystal placed within a lead shielding. With regard to the particles and quantums released through ^{198}Au decay, a detection probability $\epsilon_\beta \approx 0.3$, or $\epsilon_\gamma \approx 0.1$ respectively can be obtained. In both channels dead time stages ranging from 7 to 5 microseconds are inserted before the coincidence stage. Coincidence resolving time is (0.943 ± 0.005) microseconds. Decay rates from 150 s^{-1} up to 35,000 s^{-1} can be measured with an uncertainty of about ±1 percent (^{198}Au), or ±0.5 percent (^{60}Co) respectively being obtainable under optimum conditions. (auth)

37608 ANALYSIS OF CORRECTIONS DURING MEASUREMENTS OF CHARGE OF A SEMICONDUCTOR DETECTOR. Cirilov, B.; Smelcerovic, M. (Inst. of Nuclear Sciences, Vinca, Yugoslavia). Isotopenpraxis; 6: 456-9(Dec 1970).

The amplitude of signals coming from a semiconductor detector depends on the amplifier system filter networks, detector physical properties, and the energy of particles measured. The absolute measurements of the detector charge requires an analysis of the influence of the mentioned parameters upon the measuring system reaction. The theoretical concepts and correction diagrams for the optimum filter networks of CR–RC and CR–$(RC)^2$ types taking into consideration the existence of an undesirable integrating constant of the charge sensitive preamplifier are given. The application of the presented diagrams increases the accuracy and helps in checking the obtained results by a pulse generator. (auth)

37609 IMPROVEMENTS TO PARTICLE COUNTER TUBES. Sekhavat, Ali. French Patent 2,029,249. 5 Oct 1970. Filed 21 Jan 1969. (In French).

A Geiger-Mueller counter consisting of a closed space permeable to the radiation to be detected, a tubular cathode, and an anode arranged inside the volume defined by the cathode, is described. The anode consists of several wires nearly parallel to the axis of the cathode. The characteristics of this counter are superior to those of conventional counters: lower threshold, longer and steeper sloped plateau, reduced dead time and higher efficiency. (France)

37610 MULTIPLE COUNTER TUBE FOR A NUCLEAR RADIATION METER. Maillot, Jean-Paul (to Le Materiel Telephonique). French Patent 2,030,491. 2 Nov 1970. Filed 31 Jan 1969. (In French).

A Geiger-Mueller counter tube is described for measuring radiation intensities in a dynamic range greater than 10,000 (40 decibels), with a single scale and without switching. The tube is of the multiple type with n radiation sensitive gaps. The n sensitive gaps are included in a single envelope and are filled with the same gas; they have a common anode although the n cathodes have different dimensions. The sensitivity of a gap is proportional to the area of the corresponding cathode. The n cathodes may be metallic cylinders with solid or spiraled walls coaxial to a common anode wire and set one behind the other. (France)

37611 PORTABLE DETECTOR FOR IONIZING RADIATIONS. Bermann, Francis; Dioux, Claude; Courtaud, Paul; (and others) (to Commissariat a l'Energie Atomique). French Patent 2,034,183. 11 Dec 1970. Filed 18 Feb 1969. (In French).

A pen type dosimeter for measuring x and γ radiation was developed consisting of a microscope, an electroscope, and a ferrule for charging the electroscope. The components are contained in a casing. The electroscope is mounted on the microscope objective lens holder and is situated in an ionization chamber limited by a sealing wall. A sheath of calibrated thickness is mounted on the casing and is movable between two positions, covering the wall or exposing it. (France)

37612 RESPONSE OF SILICON SURFACE BARRIER DETECTORS TO HEAVY IONS. Karcher, T.; Wotherspoon, N. (New York Univ., N. Y.). Nucl. Instrum. Methods; 93: No. 3, 519-23(1971).

The response of silicon surface barrier detectors to ions of H, He, C, N, Ne and Ar at energies from 20 to 400 keV is measured and compared with the theory of the energy loss of heavy charged projectiles in matter. The data follow the general trends of the theory and extend the range of usefulness of silicon detectors to low energies where the response is no longer proportional to the projectile energy. The pulse height distributions are consistently wider than predicted from the theory of energy-loss straggling. (auth)

37613 SEMI-AUTOMATIC SCANNING OF TRACKS IN PLASTICS. Khan, H. A. (Univ. of Birmingham, Eng.). Radiat. Eff.; 8: No. 1-2, 135-8(Mar 1971).

Light scattering (spot density) was found to be a good method of counting tracks in 127-μm thick plastic foils which were exposed to ^{252}Cf fission fragments and alpha particles and then etched in 6.25 N KOH. The effects of etching time were studied, and foils of Lexan, Macrofol, and cellulose acetate (T-Cellit) were calibrated for a method for semi-automatic scanning of tracks. The reproducibility of the method was determined in tests. For very low fluxes, a red dye method was devised which results in easily seen impressions of the holes; 10-μm thick Macrofol foils gave almost quantitative yields for 25 to 65 fission fragments. (D.L.C.)

37614 PROPORTIONAL CHAMBER FOR COMPENSATION GEOMETRY IN TIME-OF-FLIGHT MEASUREMENTS. Cisek, Z.; Peshekhonov, V. D.; Rongin, A. J.; Turala, M.; Zanevskii, Yu. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 93: No. 3, 493-4(1971).

The usage of a multiwire proportional chamber for compensation geometry in time-of-flight measurements is suggested. The proposed method reduces completely the effect of the scintillator length on the time resolution of the spectrometer. (auth)

37615 NEUTRON DETECTION EFFICIENCY OF AN ORGANIC SCINTILLATOR. Mubarakmand, S.; Anwar, M. (Atomic Energy Centre, Lahore). Nucl. Instrum. Methods; 93: No. 3, 515-18(1971).

Absolute neutron detection efficiency of an organic liquid scintillator has been measured in the energy range 3.24 to 13 MeV. Elastic n-p scattering at 14.7 MeV has been used as the standard reaction in the measurement. The experimental data are compared with the theoretical efficiency curve. (auth)

37616 INTERNAL SAMPLE INTRODUCTION SYSTEM FOR A FLOW GAS PROPORTIONAL COUNTER. Bugenis, C. K.; Artman, C. A.; Preuss, L. E. (Edsel B. Ford Inst. for Medical Research, Detroit). Nucl. Instrum. Methods; 93: No. 3, 525-7 (1971).

A device for introducing samples into the interior of a flow-gas proportional counter for soft X-ray spectrometry is described. It functions as a gate operated air lock, minimizing contamination of the P-10 gas. The absence of an entrance window and the exterior air path reduces low energy photon attenuation associated with these barriers. A plane sample geometry held tangential to the inner cathode surface minimizes field distortion. The use of low Z materials throughout reduces fluorescence effects. Several spectra are included to demonstrate the increased efficiency of detection obtained in the internal mode (greater than 100 times as efficient as the external mode). (auth)

37617 EFFECT OF DISLOCATION DEFECTS IN GERMANIUM MONOCRYSTALS ON Ge(Li) DETECTOR PROPERTIES. Mraz, J.; Kasak, F. (Nuclear Research Inst., Prague). Nucl. Instrum. Methods; 93: No. 3, 589-91(1971).

The effect of the inhomogeneous distribution of dislocations resulting from dislocation defects (slips, small angle grain boundaries) on the detector resolution is studied. (auth)

37618 RECIPROCAL MULTIPLICATION METER. Sheets, W. R. (Dow Chemical Co., Golden, Colo.). Nucl. Technol.; 11: No. 1, 96-8(May 1971).

A reciprocal multiplication (1/M) meter has been developed and successfully used during numerous critical mass experiments. The instrument provides continuous reciprocal multiplication data ranging from 1 to 10^{-3} from a panel meter and pen recorder throughout the approach to critical. Recorded graphs show typical approaches to critical. The instrument is also used during hand stacking and in situ experiments. (auth)

37619 MEASUREMENT OF NEUTRON FLUENCE BY ^{237}Np AND ^{238}U FISSION DOSIMETERS. Barry, K. M. (Westinghouse Nuclear Energy Systems, Pittsburgh); Corbett, J. A. Nucl. Technol.; 11: No. 1, 120-30(May 1971).

Experimental irradiations of pressure vessel materials were conducted at the Saxton reactor and Babcock and Wilcox Test Reactor to provide radiation effects data for fast neutron fluences up to 1×10^{20} ncm^{-2} (E > 1 MeV). Included in the capsule assemblies were ^{237}Np and ^{238}U dosimeters and ^{54}Fe correlation monitors. The activities of the dosimeters were combined with the neutron spectrum calculations of a multigroup diffusion code to establish the fast neutron (E > 1 MeV) fluences experienced by the dosimeters. For both reactors the fluences derived from the different dosimeters were in good agreement indicating both the adequacy of the spectral predictions and the successful application of the fission dosimeters. It is shown that the ^{237}Np and ^{238}U dosimeters are responsive to a wider range of neutron energies than the more commonly used threshold detectors and are therefore better able to assure the aptness of calculated neutron spectra. This effort has indicated that the use of ^{237}Np and ^{238}U dosimeters in power reactor vessel surveillance programs leads to more meaningful correlations between neutron fluence and induced radiation effects. (auth)

37620 ON-LINE MONITOR OF NATURAL GAS LINES FOR ^{3}H AND ^{85}Kr. Brundage, Robert S. (CER Geonuclear Corp., Las Vegas, Nev.); Motes, Bill G.; Gant, Preston. Nucl. Technol.; 11: No. 3, 400-5(Jul 1971).

A system has been developed and tested for continuously monitoring a natural gas stream for the beta activity of both tritium and krypton-85. The system makes use of a proportional counter whose sensitive volume is limited to about 24% of the total volume by a set of four separate cathode frameworks. This feature avoids a buildup of background activity due to the daughter products of radon-222, which tend to plate out in insensitive regions of the counter. Appropriate pressure, temperature and flow controls are provided to operate the system either in the static or flowing mode. In the latter, the residence time of the counting gas is about ten minutes. An Fe-55 source (5.9 keV Mn-55 x-rays) is used for calibrating the system gain. Calibration constants and pulse distribution factors are determined for operating conditions of pressure (2.75 bars, 40 psia), temperature (38°C) and gain in the presence of the sample gas by dilution with standard gases made with commercial grade CH_4 having known specific activities of either tritium or krypton-85. The system threshold for detection of either tritium or krypton-85 has been determined to be about 2×10^{-3} pCi/cc in the absence of radon-222 and a factor of 3 greater with typical concentrations of radon-222. Estimates are given for the threshold for detection of either activity, tritium or krypton-85, in the presence of the other, 10% of the krypton-85 activity for tritium and a few percent of the tritium activity for krypton-85. (auth)

37621 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR USE IN DEVICES FOR INVESTIGATING THE DISTRIBUTION OF RADIATION FROM AN EXTENDED SOURCE OF IONISING RAYS. Mallard, John Rowland; Wilks, Robin John (to National Research Development Corp.). British Patent 1,231,498. 12 May 1971. Filed 5 Aug 1968.

Reference is made to gamma cameras and, in particular, to improved collimating means for such cameras. With conventional collimators the image produced consists of an array of areas of light separated by dark channels that can mask fine detail and limit resolution to about 1 cm; this limit is not entirely satisfactory for diagnostic purposes. The collimator described has a number of apertures for the γ-radiation, arrayed in a two-dimensional array in a plane at right angles to the collimating axis, together with a scintillation screen to receive the collimated radiation, an image-intensifier vacuum tube having a photo-cathode, and means for forming an image of the distribution of light from the scintillation screen on the photo-cathode. The collimator is mounted with freedom for movement so that during investigation of a γ-source it can be moved in such a manner as to improve the definition of the image. Means may be provided for operating the image intensifier only in response to selected scintillations of the screen; this may comprise a number of photomultipliers arranged around the periphery of a light guide, together with photomultiplier-pulse amplifying means, pulse-height analyzing means, and means for operating the image intensifier in response only to pulses of predetermined magnitude selected by the pulse-height analyzer. (UK)

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37622 IMPROVEMENTS IN OR RELATING TO THE MONITORING OF GAS STREAMS FOR RADIOACTIVITY. Perry, Kenneth Edward Gordon (to United Kingdom Atomic Energy Authority). British Patent 1,231,396. 12 May 1971. Filed 31 Jul 1967.

Reference is made to improved means for the monitoring of stack gases from nuclear reactors and other plants using radioactive materials. Two classes of radioactivity are considered: radioisotopes that may enter and be retained in the body, and active inert gases that introduced radioactivity into the air so that irradiation from the ambient atmosphere occurs. A typical monitoring technique is to monitor a filter designed to retain the first type of activity and to monitor the second kind of activity by a γ-counter located downstream of the filter. This serves where the monitored gas stream is of fairly constant composition, but in many cases the composition is not so predictable and is liable to contain β-emitters whose γ-emission is not truly representative of their hazards. In the system described the gas stream from the filter is passed serially through a beta monitor and a gamma monitor. Provision is made for a replacement charge of iodine absorbent. (UK)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 37683, 38926, 38973, and 39011.

37623 (AERE-R-6748) DIODE: A COMPUTER PROGRAM FOR THE COMPREHENSIVE EVALUATION OF GAMMA SPECTRA. Bullock, R. J.; Large, N. R. (Atomic Energy Research Establishment, Harwell (England)). Apr 1971. 31p. Dep. NTIS (U. S. Sales Only). UK 25p.

DIODE is a versatile computer program for the processing of gamma spectra obtained from Ge(Li) detectors. It will accept data from several different types of multichannel analyzers, and presents options ranging from a simple print-out of the spectrum to a complete analysis. The constituents can be identified and their activities determined by comparison with a library of gamma ray energies and intensities. Graphical output can also be obtained if desired. DIODE is written in FORTRAN IV for an IBM 360/75 computer. (auth) (UK)

37624 (CEA-R-4038) DEVELOPMENT OF A SIGNAL PROCESSING SYSTEM APPLICABLE IN NUCLEAR SPECTROMETRY. Lacorre, Jean (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires. Grenoble Univ. (France). Faculte des Sciences). Jan 1971. 87p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Grenoble Univ. (France). Faculte des Sciences.

Various sources of noise present in the charge preamplifier and in the semiconductor detector are studied. Both the physical processes responsible for the noise and their localization are analyzed. The behavior of the field effect transistor constituting the preamplifier input is studied as a function of temperature. A theoretical study is made of a system for processing the signal produced by a gamma spectrometry chain. The processing is of the type $\int_0^T P(t) \ldots dt$ in which P(t) is a qualified weighting function deduced from the theoretical weighting function, giving the optimum processing from the point of view of the minimum quadratic error criterion. The degradation of the signal to noise ratio is studied as a function of the degree of quantification. The effect of time dispersion on the time of departure of the analysis is studied, and the theory is verified by experimental measurements. (auth) (France)

37625 (JPRS-53090, pp 1-17) METHODS AND DEVICES FOR MEASURING THE RADIOACTIVITY OF SEA WATER. Nelepo, B. A.; Vinogradov, A. S. Translation of pp 88-102 from Sovremennaya Apparatura Dlya Okeanograficheskikh Issledovaniy; Sevastopol', Marine Hydrophysical Institute, Ukrainian SSR Academy of Sciences, 27 Mar 1970.

The introduction points out the advantages of direct measurements of the gamma radiation of sea water over measurements using a sampling technique. A number of devices for direct observation are then described. Although both radiometers and spectrometers were previously used, the latter have almost completely replaced the former at this time. (R.W.R.)

37626 ANTICOINCIDENCE-SHIELDED DUAL Ge(Li) GAMMA-RAY SPECTROMETER FOR LOW-LEVEL ENVIRONMENTAL RADIONUCLIDE ANALYSIS AND GAMMA-GAMMA COINCIDENCE STUDIES. Cooper, J. A.; Perkins, R. W. (Battelle Memorial Inst., Richland, Wash.). Nucl. Instrum. Methods; 94: No. 1, 29-38(1971).

A high-efficiency anticoincidence-shielded Ge(Li) gamma-ray spectrometer incorporating 70 and 80 cm^3 Ge(Li) detectors with high resolution has been developed which provides greater sensitivity and versatility for measuring low levels of radionuclides in environmental samples than previously reported Ge(Li) spectrometers. Its sensitivity is sufficient for measuring many radionuclides at activity levels less than 1 dpm with counting intervals of only 1000 min and has provided the first nondestructive instrumental measurement of ^{108m}Ag in environmental samples. Examples of its application to other low level environmental problems are illustrated and discussed. Its analytical applications as a gamma-gamma coincidence spectrometer are also discussed. (auth)

37627 UTILIZATION OF A CHAIN OF CURRENT PULSES FOR THE SPECTROSCOPY OF IN-PILE NEUTRONS. Jeandidier,; Leridon, A.; Moroni, M.; Rogerieux, M. (CEN, Cadarache, France). Nucl. Instrum. Methods; 94: No. 1, 13-21 (1971). (In French).

In pile neutron spectrometry it is important to understand the physics of fast reactors. In order to extend the technique of proton recoil counter spectrometry to high counting rates, a current pulse amplifier system was developed. It is shown that this system allows a factor of 5 in the counting rate without any linearity distortion. Despite the variation of pulse shapes, gamma-neutron discrimination is also possible with such a device. The comparison between conventional electronics and current pulse electronics is shown on a typical spectrum. (auth)

37628 INFLUENCE OF THE SLIT LENGTH ON THE RESOLUTION OF PLANE AND CYLINDRICAL ELECTROSTATIC SPECTROMETERS. Roy, D.; De Celles, M.; Carette, J. D. (Laval Univ., Quebec). Rev. Phys. Appl.: 6: No. 1, 51-4(Mar 1971). (In French).

A method for calculating the energy distribution of electrons transmitted by cylindrical and parallel plate electrostatic spectrometers is presented: it takes into account the tridimensional aspect of the problem and is based on statistical studies. This method allows one not only to evaluate the distribution broadening but also to draw its profile from the distribution obtained in the bidimensional case. These distributions, calculated for various lengths of the spectrometer slits give the influence of this parameter on the resolving power of these apparatus. (auth) (France)

37629 THICK TARGET METHOD FOR THE MEASUREMENT OF NEUTRON DIFFERENTIAL SCATTERING CROSS SECTIONS. Albert, T. E. (Martin Marietta Corp., Orlando, Fla.); Carroll, E. E. Nucl. Instrum. Methods; 94: No. 1, 173-7(1971).

A time-of-flight method for measuring fast neutron elastic and inelastic scattering cross sections is described. This technique uses nanosecond bursts of deuterons from a Van de Graaff accelerator to produce a broad spectrum of neutrons from a thick beryllium or lithium target. The pulse height spectrum from a proton recoil scintillator is unfolded to yield the scattered neutron spectrum. Scattering processes may be studied where the energy level of the residual nucleus is separated from adjacent levels more than the resolution width of the detector used (e.g. 10% to 15% at 5 MeV for Nuclear Enterprises 213 liquid scintillator). If the detector can resolve such a scattering process, then the energy resolution of the cross section measurement is that of the time-of-flight analysis. All energies from ≈0.5 MeV to the maximum source neutron energy are measured simultaneously. Cross sections and angular distributions are presented for scattering to the ground state and first excited state of ^{56}Fe between 2.70 MeV and 6.62 MeV with about 5 percent energy resolution. (auth)

37630 BACKGROUND IN ASSOCIATED-PARTICLE TIME-OF-FLIGHT TECHNIQUE. Matoba, M.; Hyakutake, M.; Yamamoto, H.; Katase, A.; Sonoda, M. (Kyushu Univ., Fukuoka). Nucl. Instrum. Methods; 94: No. 1, 199-201(1971).

The background which limits the use of the associated-particle in the neutron time-of-flight technique is considered in a model experiment of $^{238}U(n,f)$ reaction induced by 14 MeV neutrons. It is found that the background in the flight-time spectrum does not vanish even in the ideal case in which there are no sources of "uncorrelated" events. (auth)

37631 CONDITIONAL STABILITY IN MOESSBAUER DRIVE SYSTEMS. De Waard, H.; Pijpker, B. A.; Greve, P. F. (Rijksuniversiteit, Groningen, Netherlands). Nucl. Instrum. Methods; 94: No. 1, 195-7(1971).

Electromechanical feedback systems may become regenerative after a sudden mechanical disturbance. This "conditionally stable" behaviour is found to be due to a time lag in operational amplifiers occurring when they are saturated. The systems can be made unconditionally stable by "bounding" the output signal of these amplifiers. (auth)

37632 PRODUCTION OF N–I–P Ge DIODES: USE IN GAMMA SPECTROSCOPY. Henck, R. (CNRS, Strasbourg). pp 189-201 of Comptes Rendus du 92e Congres National des Societes Savantes, Tome 2. Paris; Bibliotheque Nationale (1970). (In French).

From ninety-second national congress of the Learned Societies; Strasbourg, France (31 Mar 1967). See CONF-670342–(Vol. 2).

Lithium drifted germanium detectors of various volumes (1 to 40 cm^3) and diverse structures (plane, coaxial) have been produced. The methods used to fabricate the diodes, and their characteristics at liquid air temperatures, are presented. The detectors are used in diverse γ ray spectrometry experiments and over a very wide energy range (some keV to several MeV). The use of field effect transistors enables the determination of γ ray energies with an accuracy greater than one part in a thousand. (auth) (France)

37633 FACILITY FOR THE MEASUREMENT OF NEUTRON-CAPTURE CROSS SECTIONS FROM 0.01 eV TO 1 MeV. Friesenhahn, S. J.; Lopez, W. M.; Carlson, A. D.; Fricke, M. P. (Gulf Radiation ETech., San Diego, Calif.). Nucl. Instrum. Methods; 93: No. 3, 477-92(1971).

A facility has been constructed at Gulf Energy & Environmental Systems, Inc., to measure neutron-capture cross sections throughout the full neutron-energy region of interest in reactor design. Neutron-flux measurement techniques have been developed that yield absolute values with greater precision than has been previously achieved in time-of-flight measurements. The $^{10}B(n,\alpha)^7Li$ and the hydrogen-scattering cross sections are used as standard cross sections for flux measurements below and above 80 keV, respectively. The $^3He(n,p)T$ cross section was also measured to allow detectors based on this cross section to be used as secondary flux standards. Two neutron flight paths with lengths of 20 and 230 m are used in a complementary fashion to optimize data accumulation, and large liquid scintillators are used at both flight paths to detect the capture gamma rays. These scintillators have been designed to achieve good gamma-ray energy resolution and timing characteristics while preserving a maximum of experimental flexibility. (auth)

37634 VELOCITY SMEARING. Wender, S. A.; Hershkowitz, N. (Univ. of Iowa, Iowa City). Nucl. Instrum. Methods; 93: No. 3, 571-2(1971).

The effect of velocity smearing on a Lorentzian line shape in Moessbauer spectra is considered. (auth)

37635 AUTOMATIC ANALYSIS OF HIGH-RESOLUTION GAMMA SPECTRA. Grosswendt, B. (Physikalisch-Technische, Brunswick). Nucl. Instrum. Methods; 93: No. 3, 461-72(1971). (In German).

A computer program permitting the automatic analysis of high-resolution pulse-height spectra is described. The method for finding the peaks in a pulse-height spectrum uses the difference between the measured counts per channel and a simulated background, which is calculated by smoothing the measured data. After subtraction of the simulated background from the pulse-height distribution, the structure of the new data shows regions lying above the statistical fluctuations near Compton edges and peaks only, which easily can be analysed by the use of a least-squares fitting calculation. By this technique the calculation of the first or second differences of the counting rates as a function of the channel number and the application of the correlation technique could be avoided. The application of the evaluated method to a complicated pulse-height spectrum shows its usefulness for the analysis of measured gamma-ray spectra. (auth)

37636 ASSOCIATED GAMMA RAY TIME OF FLIGHT SPECTROMETER WITH HIGH NEUTRON EFFICIENCY. Johnson, P. B.; Caraca, J. M. G.; Pihl, J. N.; Gill, R. D.; Rose, H. J. (Oxford Univ.). Nucl. Instrum. Methods; 93: No. 3, 417-24 (1971).

A high efficiency, associated gamma ray time of flight spectrometer for the study of (n,γ) angular correlations following (charged particle,n) reactions is described. The neutron detector employs eight XP1040 photomultiplier tubes viewing four tanks of NE213 liquid scintiliator, and subtends a solid angle of 0.092 sterad at the target when the neutron flight path is two meters. Neutron events in the scintillator are identified by means of pulse shape discrimination. The use of constant fraction pulse height discriminators to provide fast timing pulses, enables the use of a wide dynamic pulse height range in both the neutron and gamma ray detectors. This method of timing enables the gamma ray detector to be changed from a Ge(Li) counter, to a NaI(Tl) or other type of scintillation detector with only a minimal rearrangement of the electronic system. (auth)

37637 DYNAMICALLY BIASED NEUTRON DETECTOR FOR BACKGROUND REDUCTION WITH A FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER. Brandenberger, J. D.; Grandy, T. B. (Univ. of Kentucky, Lexington). Nucl. Instrum. Methods; 93: No. 3, 495-508(1971).

A neutron time-of-flight system has been developed which has dynamically changing bias levels rather than the single fixed level used by the conventional neutron time-of-flight system. This method of biasing was developed to reduce background in the study of (n,n′) reactions. Additionally, the dynamically biased system has the following features: (1) a neutron detection efficiency which is approximately proportional to the total neutron–proton scattering cross section; (2) a neutron energy response which, in theory, has no lower limit. In practice, however, one may wish to impose a bias just above the photomultiplier noise; and (3) improved time resolution for neutron detection. (auth)

37638 CORRECTIONS FOR DEAD-TIME LOSSES IN THE MEASUREMENT OF GAMMA-RAY SPECTRA OF SHORT-LIVED RADIONUCLIDES. Das, H. A.; Zonderhuis, J. (Research Centrum Nederland, Petten). Nucl. Technol.: 10: No. 3, 328-34 (Mar 1971).

Multichannel-analyzers are necessary tools in activation analysis. The reliability of the analytical results depends on the correction for dead-time. When measuring long-lived radionuclides, this correction is automatically applied in all modern instruments by lengthening the counting time. This procedure is not sufficient in the case of short-lived species. A residual error will remain. The correction to be applied depends on the total dead-time at the beginning of the measurement and on the ratio preset time/half-life. The first quantity can be read from the analyzer. (auth)

37639 COMPOSITE SOLID STATE RADIATION DETECTOR, (to Princeton Gamma-Tech, Inc.). British Patent 1,233,607. 26 May 1971. Priority date 8 Aug 1967, United States.

A semiconductor detector that is composite in form is described. It may be constructed from several detectors of the P–I–N type or from a single, specially made detector describable as N–I–P–I–N. The various sections can be connected electronically so that only those electrical pulses from a single gamma ray that deposits part of its energy in one detector and the remaining energy in another are recorded. With this invention spectra are obtained such that Compton edges are eliminated and backgrounds are so greatly reduced that low-intensity gamma rays may be more readily observed in the midst of a complex spectrum. (R.W.R.)

37640 GILES' GAS RECOIL NEUTRON SPECTROMETER, Mizuho, Mitsuru (to Japan Atomic Energy Research Inst.). U. S. Patent 3,524,061. 11 Aug 1970. Priority date 21 May 1963, Japan.

A Giles' gas recoil neutron spectrometer with a main detector and a series of subsidiary detectors is described; the latter provides a coincidence signal to the main detector that eliminates the effects of wide-angle recoils. (auth)

High Energy Physics Instrumentation

Refer also to abstract 39334.

37641 HIGH-ENERGY CHARGED PARTICLES SEPARATION BY MEANS OF A CASCADE OF MULTIWIRE PROPORTIONAL CHAMBERS. Dimcovski, Z.; Favier, J.; Charpak, G.; Amato, G. (CERN, Geneva). Nucl. Instrum. Methods; 94: No. 1, 151-5(1971).

The energy losses of charged particles traversing 30 proportional chambers are measured simultaneously. The relativistic rise of ionization is investigated in several gases. A maximum increase of 45% is observed in a mixture of argon-propane, where Landau theory predicts an increase of 78%. The application of these measurements for particle separation is discussed. (auth)

37642 MULTIPLE TRACK EFFICIENCY TEST SYSTEM FOR THIN SPARK CHAMBERS. Morgado, R.; Peterson, V. Z.; Shiraishi, L. (Univ. of Hawaii, Honolulu). Nucl. Instrum. Methods; 94 No. 1, 189-91(1971).

A compact, lightweight system of permanent magnets and scintillators arranged to deflect beta particles from a radioactive source along an S-shaped curve through a thin plane spark chamber in such a manner that the beta particles make three separate traversals of the chamber is described. (auth)

37643 DEVICE FOR CONTROLLING THE SPARKING IN A SPARK CHAMBER. Lansiart, Alain; Leloup, Jean; Morucci, Jean-Pierre; Roux, Georges (to Commissariat a l'Energie Atomique). French Patent 1,465,531. 15 Jun 1970. Filed 26 Feb 1968. 2nd Addition 95,138. (In French).

Improvements made to a device for controlling the discharge in

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a particle detector are described. A short circuit device is associated with the detector. In the sparking region, the detector tube has an anode with a high surface resistance (between 5000 ohms and 9000 ohms per square area). The delay introduced by the short circuit device is arranged so that the short circuit phenomena intervenes during the initial phase of the spark formation. A resistance (500–1500 ohms) is mounted in series between the shunt and one of the electrodes; this limits the multiplication space. In the avalanche region the sum of the delays due to the amplifiers and the short circuit devices is less than the time between the appearance of the spark and the appearance of the grid current, and is equal to about 20% of the plateau. The short circuit device is mounted in series with a high input impedance FET amplifier with a large bandwidth and low noise, a high gain large bandwidth amplifier, and a reversing cable. The amplifier is protected by an assembly of diodes mounted head to tail between the detector grid and earth. The shunt consists of a device with a supplementary delay. (France)

37644 UTILIZATION OF SEMICONDUCTOR TELESCOPES FOR DETECTION OF THE RECOIL NUCLEUS IN PROTON–LIGHT NUCLEUS INTERACTIONS AT HIGH ENERGY. Brossard, M. (Faculte des Sciences, Clermont-Ferrand, France); Combe, J.; Fain, J.; (and others). Nucl. Instrum. Methods; 93: No. 3, 529-34(1971). (In French).

The use of semiconductor telescopes to detect and to identify the recoil nucleus in proton nucleus coherent interactions at 600 MeV is described. Preliminary results are obtained using ^{3}He and ^{4}He gaseous targets with a pressure of one atmosphere. A mean precision of 1% was reached on the quadrimomentum transfer of the elastic interaction. (auth)

37645 OPTICAL TRANSMITTANCE OF COMMON CHERENKOV COUNTER GASES. Garwin, E. L.; Roder, A. (Stanford Linear Accelerator Center, Calif.). Nucl. Instrum. Methods; 93: No. 3, 593-4(1971).

The optical transmittance of the commonly used Cherenkov counter gases, Freon 12, Freon 13, CO_2, SF_6, and N_2, was measured in the range from 1875Å to 8000Å, and normalized for a 100 cm × 1 atm path. (auth)

37646 ROLE OF COMPUTERS IN THE ANALYSIS OF BUBBLE CHAMBER FILM. Snyder, James N. (Univ. of Illinois, Urbana). pp 463-78 of Computers and Their Role in the Physical Sciences. /Fernbach, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

A survey of the various types of computer-based systems for bubble chamber data analysis is presented. A historical description, operating principles, and costs of the various computer-based analysis systems are reviewed. (22 references) (W.H.K.)

37647 RECOGNITION OF VISUAL DATA IN HIGH-ENERGY PHYSICS. Kowarski, L. (CERN, Geneva). pp 479-502 of Computers and Their Role in the Physical Sciences. /Fernbach, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

The operating principles of bubble and spark chambers are briefly described, and the historical evolution of particle track measuring systems is discussed. The Franckenstein measuring system, mechanized measuring systems, automated recognition systems, and the retreat from full automation are discussed. The simpler problem of spark chamber track analysis is reviewed, and future trends and developments are considered. (W.H.K.)

Radiation Dosimeters

Refer also to abstracts 37795, 37796, and 38825.

37648 (NP–18864) THERMOLUMINESCENT PROPERTIES OF MANGANESE DOPED CALCIUM FLUORIDE. APPLICATIONS IN RADIATION DOSIMETRY. Puite, K. J. (Groningen Rijksuniversiteit (Netherlands)). 1971. 78p.

The thermoluminescent (TL) properties of CaF_2: Mn (3–4 mole %) have been studied. It was shown that uv exposure of already read out CaF_2 gave rise to a second reading. The TL sensitivity of CaF_2 for alpha particles and protons and for thermal and fast neutrons was investigated. Use was made of the $^{10}B(n,\alpha)^7Li$ and $^{14}N(n,p)^{14}C$ reactions occurring in boron- and nitrogen-containing liquids surrounding the powder. Thermally stimulated exo-electron emission and TL measurements using CaF_2 samples doped with 0.1 mole % and 2 mole % Mn and undoped samples have led to the conclusion that both electron- and hole traps are present in the CaF_2: Mn; Y^{3+} and other trivalent rare earth ions, being the electron traps and Mn^{2+} ions, being the hole traps. Preliminary TL experiments on collagen are also reported. (D.L.C.)

37649 COLORMETRIC DOSIMETRY. Huebner, K.; Prokert, K. (Technische Univ., Dresden). Isotopenpraxis; 7: No. 2, 43-50(Feb 1971). (In German).

A review on colorimetric dosimetry is presented. The theory of colorimetric dosimeters is described, and recent developments and techniques using organic dyes are surveyed. (120 references) (W.H.K.)

37650 SENSITIVITY OF NEUTRON DOSIMETER IN 1 TO 100 keV RANGE. Druskina, L. S.; Pavlov, V. D.; Shaver, I. Kh. Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 1, 39-40(1971). (In Russian).

Calibration of the neutron dosimeter in the 1 to 100 keV energy range on a Van de Graaff generator has been carried out. A satisfactory agreement of the experimental data with those obtained by calculation was established. (auth)

37651 FILM BADGE WITH IMPROVED RADIATION FILTERING STRUCTURES. Clarke, Eric T. (to Technical Operations, Inc.). U. S. Patent 3,567,934. 2 Mar 1971. Filed 30 Aug 1968.

A radiation monitoring film pack and a holder therefor are disclosed. The film pack has a wrapper with a flap extending from it carrying identifying data. The holder defines a slot for receiving the film pack novel U-shaped radiation filters for shielding the film from edgewise, as well as head-on radiation, and a frame which overlies the film-holding structure and holds the flap such that a surface on which the identifying data appears is visible. (auth)

37652 HINGED RADIOLOGICAL FILM BADGE WITH FOLD-OVER FILM PACKET. Prest, Robert J. (to Technical Operations Inc.). U. S. Patent 3,567,933. 2 Mar 1971. Filed 28 Sep 1967.

A radiation monitoring film pack and a holder therefor are disclosed. The film pack has a wrapper with a flap extending from it for identifying data. The holder has means to hold the film pack, with suitable radiation filters, and a frame which overlies the film-holding structure and holds the flap framed on it with a surface visible on which the identifying data may appear. (auth)

37653 COSMIC-RAY TRACKS IN PLASTICS: THE APOLLO HELMET DOSIMETRY EXPERIMENT. Comstock, G. M.: Fleischer, R. L.: Giard, W. R.: (and others) (General Electric Research and Development Center, Schenectady, N. Y.). Science; 172: 154-7(9 Apr 1971).

Counts of tracks from heavy cosmic-ray nuclei in helmets from Apollo missions 8 and 12 show variations caused by solar modulation of the galactic cosmic-ray flux. Specific estimates of the biological damage to certain nonreplaceable cells by track-forming particles during these space missions indicate that the fraction of deactivated cells could range from a lower limit of 3×10^{-7} to an upper limit of 1.4×10^{-4}. (auth)

37654 NEUTRON DOSIMETER. Piesch, Ernst (to Gesellschaft fuer Kernforschung mbH). German Patent 1,464,952. 3 Jul 1969. Filed 23 Jul 1964. (In German).

A dosimeter is described for the measurement of a neutron dose or the intensity of a neutron dose comprising a measuring device of which the maximum sensitivity is situated in a region of limited measurement. This region is surrounded by absorbing moderators or other substances which are provided with a view to extending the measurement to the whole energy range of average neutrons. Some examples are geometrical systems designed for adjusting the action of neutron radiation on the cell of measurement. (auth)

37655 PHOTOGRAPHIC TECHNIQUE FOR DOSIMETRY USING SILVER ACTIVATED PHOSPHATE-GLASS PLATES. Hopkins, B. J. H.; Baxter, R. C. (Univ. of Rochester, N. Y.). Health Phys.; 20: No. 6, 645-7(Jun 1971).

Multiply scattered ultraviolet light was filtered and collimated before striking silver activated glass plates, previously exposed to ionizing radiation. The orange light emitted by the plates was passed through an orange filter and photographed. The optical densities of the images produced simultaneously by calibrated and unknown samples on the resultant negatives were measured. Film exposures varied between 0.5 and 4 hrs over a dose range 10^2 to 10^4 rad. No decay in radiophotoluminescence was found after 16 hrs exposure of the glass. (UK)

Radiometric Instruments

37656 NUCLEONIC GAUGES WITH TRAVERSING HEADS, AND DRIVE THEREFOR. Trachevski, George J.; Crawford,

Juan H. (to Industrial Nucleonics Corp.). U. S. Patent 3,575,600. 20 Apr 1971. Filed 1 May 1968.

An enclosed O-bracket type traversing system for nucleonic or radioactive gauging apparatus includes a flexible tension member interconnected with the source and detector heads to form an endless loop for accurate maintenance of registration and alignment throughout the range of traversing movement. (auth)

37657 APPARATUS FOR MEASURING THE MOISTURE CONTENT AND DENSITY OF THE SOIL. Rocoplan, Jean; Wack, Bernard (to Electricite de France (Service National). U. S. Patent 3,524,062. 11 Aug 1970. Priority date 23 Mar 1969, France.

A device for measuring the moisture content and density of a material, and particularly of a soil is described. The device comprises a source of fast neutrons and gamma rays and means for detecting neutrons and gamma rays which are transmitted through said material. Said source and said detection means are disposed on two opposite sides of the material. Said detection means comprise at least one neutron detector and one gamma-ray detector which are embedded in a same hydrogenated medium of predetermined volume. (auth)

37658 MULTIRANGE RADIATION THICKNESS GAUGE. Mangan, Edmund L. (to Bethlehem Steel Corp.). U. S. Patent 3,524,063. 11 Aug 1970. Filed 12 Oct 1967.

A highly accurate and responsive five-range thickness gauge directly compares material under test to digital thickness standards introduced between a constant source of radiation and a radiation detector opposite the test material. The detector operates at one of five different constant levels of sensitivity. The standards are actuated by signals from a thickness selector and programmed by an operating mode controller to complement material thickness to equal a different precalibrated thickness constant for each operating range. This produces a five-level nonlinear output voltage at the detector which is fed to a simplified multirange translator that converts it to five-level linear output voltage. This multilevel voltage is applied against a corresponding multilevel constant electrical reference in a comparison circuit which indicates percent deviation from range full scale and signals a second translator which indicates an algebraic difference as a constant decimal deviation from thickness selection. A compensator operating in a second comparison circuit with the second translator provides against output signal variations due to variations in material temperature and composition. Automatic standardization is provided in a feedback loop from the second translator to a variable gain amplifier in the first translator. (auth)

37659 GAMMA-BACKSCATTER DENSITY GAUGE WITH DIFFERENTIAL-MODE COUNTING. Ciftcioglu, O.; Taylor, D. (Univ., Strathclyde, Scotland). Nucl. Instrum. Methods; 94: No. 1, 53-9(1971).

An investigation is made of backscatter gauges using differential-mode counting using a narrow window. In the range where Compton scattering is predominant, the performance is similar to that with integral-mode counting, except that the sensitivity is very much reduced, necessitating the use of a stronger radioactive source and, as necessary, heavier shielding. However, if the spectra of the backscattered gamma-radiations are examined it will be noted that with geometry such that multiple scattering is always obtained, there is a peak intensity at about 80 keV for a ^{137}Cs source. Therefore, by using a photon detector with the window set on this energy peak, the setting should be the same for all materials and moreover the sensitivity should be high, and this proved to be the case. It is also found that the (I vs ρ) characteristic, where I is the counting rate and ρ the density of the soil under investigation, gives an I maximum at a constant ρ, independent of the source-detector separation (d). This is a quite different phenomenon to that found at higher energies, both for differential- and integral-mode counting. Regular curves are obtained. On the other hand, the (Id^n vs d) characteristics display similar properties to those obtained for integral-mode counting, namely a shift of the Id^n maxima to a different source-detector separation (d) with change of density (ρ) and with change of n value, but the (I vs d) relationship is not the same as for integral-mode counting. It is shown that over a useful range (ρ = 1.0 to 2.25 g/cm^3) the Compton mass absorption coefficient (k_2) is approximately linearly related to the density, and by introducing a new parameter ($k_3 = k_2/\rho$), a formula is derived for d_m(the source-detector separation at an Id^n maximum). This formula allows a determination of soil densities by measuring d_m experimentally. The accuracy possible is of the order of ±2%. (auth)

37660 NUCLEAR MACHMETER. Gilly, Louis (CEA, Grenoble, France). Aeronaut. Astronaut. (Paris); No. 27, 23-34 (1971). (In French).

This machmeter uses semiconductor detectors. It detects alpha particles produced by ^{241}Am sources. Pulses issued from each of these detectors are amplified and dispatched in two electronic chains. They get in a simple calculator which gives the Mach number. It is possible to associate electronic chains for obtaining separate informations of altitude and Mach number. It may be used for stabilizing altitude. The different parameters which have an effect on the counting rate are studied. Systematic analysis of experimental errors is made. (auth)

37661 IMPROVEMENTS IN NUCLEAR GAUGES. Holben, Bernard Christie; Bach, Richard Edward; Trachevski, George Joseph; Auborn, Ernest Andrew (to Industrial Nucleonics Corp.). British Patent 1,227,435. 7 Apr 1971. Priority date 27 Apr 1967, United States.

A housing for radiometric gages having a shutter that closes and locks in event of fire is described. (R.W.R.)

37662 MEASURING APPARATUS AND METHOD. Nagel, Walter A. (to Schlumberger Tech. Corp.). U. S. Patent 3,567,935. 2 Mar 1971. Filed 7 Feb 1968.

An earth formation porosity logging tool in accordance with an illustrative embodiment of the invention comprises a neutron source and four neutron detectors spaced at different distances from the source for transport through a borehole. Signals are obtained that correspond to the ratios of the counts registered by the two short-spaced detectors and the two long-spaced detectors. The effect of the borehole on the formation porosity measurement is compensated by combining these ratio signals to eliminate the influence of the borehole neutron relaxation length and converting the resultant signal into an output signal that more accurately indicates the formation porosity. (auth)

37663 NUCLEONIC MEASURING APPARATUS WITH AUTOMATIC FIRE SAFETY RADIATION SOURCE SHUTTER CLOSING AND LOCKING MEANS CONTROLLED BY A FUSIBLE ELEMENT WHICH MELTS AT HIGH TEMPERATURES. Bach, Richard E. (to Industrial Nucleonics Corp.). U. S. Patent 3,567,942. 2 Mar 1971. Filed 27 Apr 1967.

A nucleonic measuring instrument wherein a housing contains a radiation source and has an aperture controlled by a shutter which is spring loaded to a closed position for confining and shielding the radiation and is movable by a linear actuator to an open position for releasing the radiation is described. The actuator power is applied through a heat sensitive fuse so that it is deenergized and the shutter closes in response to a predetermined high ambient temperature such as may be caused by a fire, and includes a spring-biased shutter locking pin retained in a retracted position by a meltable metal barrier which melts to release the pin in response to attainment of a predetermined higher ambient temperature and lock the shutter in the closed position. (auth)

37664 MULTIPLE NEUTRON DETECTOR BOREHOLE LOGGING TOOL. Tittman, Jay (to Schlumberger Tech. Corp.). U. S. Patent 3,567,936. 2 Mar 1971. Filed 7 Feb 1968.

An earth formation porosity logging tool in accordance with an illustrative embodiment of the invention comprises a neutron source and four neutron detectors spaced at different distances from the source for transport through a borehole. Signals are obtained that correspond to the ratios of the counts registered by the two short-spaced detectors and the two long-spaced detectors. The effect of the borehole characteristics on the formation porosity measurement is compensated by directly contrasting these ratio signals with each other. A second illustrative embodiment of the invention using only three neutron detectors also is shown and described. (auth)

37665 OPTIMIZATION OF A RADIOMETRIC ARRANGEMENT FOR GAMMA-RAY MATERIALOGY. Kubicek, P. (Bergakademie, Ostrava, Czech.). Isotopenpraxis; 7: No. 2, 60-7(Feb 1971). (In German).

A theoretical analysis of a radiometric arrangement serving for fast determination under dynamic conditions of the changes in weight per unit area of materials, making use of absorption measurements is presented. With given extent of the flaw in the material and the velocity, the optimum pulse-repetition rate, discrimination level, and optimum integration constant of the rate meter were derived, at which the resolution of the arrangement obtains its maximum value. The necessary source strength was determined for a given geometry and material. The analysis takes into account fourteen parameters characterizing the radiation source, the electronic instruments, the material, and the flaw. A numerical example is calculated for a concrete instrument measuring length of shrink-holes in slabs, bars, and billets. (auth)

37666 DEVICE FOR THE DETERMINATION OF SILVER SURFACE DENSITY. Johannes, E. Isotopenpraxis; 6: 234-6 (Jul 1970). (In German).

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To maintain the quality of photographic films, the silver density per unit of area cannot fall below a certain limit. By means of characteristic x rays using an ^{241}Am gamma source, it is shown how a convenient and very economical control device could be developed for silver density measurements. (H.B.G.)

37667 METHOD AND APPARATUS FOR FILAMENT THICKNESS GAUGING. (to Atomic Energy of Canada Ltd.). British Patent 1,233,579. 26 May 1971. Priority date 14 Nov 1967, Canada.

A device for the determination of the thickness of filament material, particularly natural or synthetic fibers, by the backscattering of β, γ, or x radiation is described. (R.W.R.)

37668 TECHNIQUES IN MONTE CARLO ANALYSIS APPLIED TO THE NUCLEAR DENSITY GAUGE. Curtayne, P. C. (National Inst. for Road Research, Pretoria). Nucl. Technol.: 11: No. 1, 61-74(May 1971).

The response of the "Hidrodensimeter" nuclear density gauge for measuring road surface density is investigated by the Monte Carlo (stochastic) method. Special attention is paid to the effect of the chemical composition of the medium measured. Techniques applicable to this problem are described by which the Monte Carlo calculations can be used to better effect. Results of these calculations are compared to experimental results. (auth)

37669 ALPHA-PARTICLE DENSITOMETER WITH VARIABLE RESPONSE. Brandt, Werner; D'Agostino, Michael D.; Favale, Anthony J. (Grumman Aerospace Corp., Bethpage, N. Y.). Nucl. Technol.: 11: No. 1, 99-104(May 1971).

An alpha particle gas densitometer is described with an instrument response that can be tailored to given specifications by shaping the energy distribution of the radioactive alpha source. Relations are derived to establish the connection between a specified densitometer response and the corresponding source distribution. Shaped sources can be constructed by mounting contoured baffles on alpha sources. The operation of the densitometer is demonstrated experimentally for a linear and a logarithmic instrument response to air density variations and shown to fit these responses within experimental accuracy. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 37603, 37847, 38320, 39242, 39255, 39259, and 39289.

37670 (JPRS-53090) AIDS TO OCEANOGRAPHIC RESEARCH. Translation of pp 88-192 from Sovremennaya Apparatura Dlya Okeanograficheskikh Issledovaniy; Sevastopol', Marine Hydrophysical Institute, Ukrainian SSR Academy of Sciences, 27 Mar 1970. 114p. NTIS.

A separate abstract was prepared for one of the articles in this report. The other articles, concerning measurement of magnetic fields in the sea, autonomous measuring equipment, automated shipboard systems, and self-propelled manned vehicles for research in the oceans, are outside the scope of NSA. (R.W.R.)

For an abstract of an individual paper see: 37625.

37671 (KURRI-TR-85) EFFECT OF PRESSURE ON THE REFLECTIVITY OF NEUTRONS BY A MONOCHROMATOR CRYSTAL. (Kyoto Univ. (Japan). Research Reactor Inst.). [nd]. 6p. (In Japanese). Dep. NTIS (U. S. Sales Only).

In order to obtain neutron monochromating crystals with high reflectivities, the effect of pressure on the neutron reflectivity was studied for various single crystal specimens of Cu and Ge under the various collimating conditions. The experimentals are shown as functions of the pressure, collimation, and pressure orientation. (auth)

37672 (RISO-M-1368) TWO-PHASE FLOW MEASUREMENTS UTILIZING LASER ANEMOMETRY. Lading, Lars (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr 1971. 10p. (CONF-710318-1). Dep. NTIS (U. S. Sales Only).

From Symposium on the study of flow and turbulence by laser Doppler techniques; Coventry, England (17 Mar 1971).

A review is given of the feasibility of using laser anemometry (Doppler) for measuring flow parameters in two-phase flow. In principle it is possible to perform measurements without disturbing the flow. The basic configuration chosen is described. Some problems which are specific to two-phase measurements —and what can be done about these problems —are treated. Finally the present achievements at Risö are reviewed. (auth) (Denmark)

37673 STANDARDIZATION OF NUCLEAR REACTOR INSTRUMENTATION. Foti, Guido. Ing. Nucl.; 11: 29-32(Jan-Feb 1970). (In Italian).

The national and international societies which are concerned with the standardization in the nuclear area are reviewed. Agreements already approved are tabulated and briefly described and the agreements now under study are indicated. (tr-auth)

37674 FRINGING FIELD EFFECTS ON ELECTRON TRAJECTORIES FOR A 60^0 DOUBLE FOCUSING SECTOR MAGNET. Bhattacharya, P. K.; Bhise, V. M.; Bhiday, M. R. (Inst. of Tech. and Science, Indore, India). Indian J. Pure Appl. Phys.; 9: No. 2, 122-6(Feb 1971).

An account, using Enge's principles, of the effects of extended fringing field and short cutoff fringing field on electron trajectories inside a 60^0 double-focusing magnetic spectrometer is presented. The study has a significant bearing on the design of charged-particle beam-transport systems, with particular emphasis on the design of high-transmission (static-field) magnetic spectrometers. An intuitive grasp of the mechanism of second-order aberrations also results from this formalism and provides physical insight into the minimization or elimination of higher-order multipoles present. It seems that, for modest requirements of resolution and transmission, the first-order correction of optic-axis bending can be simply done satisfactorily by the shrouding of the beam from stray field with silicon-steel field clamps. (auth)

37675 ION-IMPLANTED MOS TECHNOLOGY. Dill, H. G.; Bower, R. W.; Toombs, T. N. (Hughes Aircraft Co., Newport Beach, Calif.). Radiat. Eff.; 7: 45-57(Jan 1971).

The current state of ion implantation as applied to MOS technology is discussed. It is shown how impurity doping by ion implantation is used to produce self-aligned MOS gate structures. The reduction in circuit capacitance gives the designer a choice of higher switching speed or lower power dissipation. The availability of a linear resistor of value 1 to 10 kΩ-cm allows many new circuit techniques to be applied to monolithic circuits. This paper discusses ion-implantation technology, device design, and circuit performance. A number of implanted circuits are shown. Finally, improvements to the present technology that are still in the R and D phase are described. (auth)

37676 DEVICE FABRICATION BY ION IMPLANTATION. MacRae, A. U. (Bell Telephone Labs., Murray Hill, N. J.). Radiat. Eff.; 7: 59-63(Jan 1971).

Ion implantation of boron and phosphorus into silicon yields material that has electrical characteristics that are similar to silicon doped by conventional techniques. These results, and the ability to control and reproduce both the number of dopant atoms and their depth distribution, have been used to considerable advantage to fabricate both discrete devices and integrated circuits by ion implantation. Resistors, junction diodes, hyperabrupt diodes, IMPATTS, and field effect transistors have been made. The narrow spread in the operating characteristics and the excellent performance of these devices, illustrate the advantages gained by using ion implantation as a step in the fabrication of devices. (auth)

37677 IMPLICATIONS OF ION IMPLANTATION TECHNOLOGY ON ION IMPLANTED ACTIVE DEVICES IN SILICON. Glotin, P.; Bernard, J.; Monfret, A. (Laboratoire d'Electronique et de Technologie de l'Informatique, Grenoble, France). Radiat. Eff.; 7: 65-72(Jan 1971).

The use of ion implantation to make integrated devices in silicon implies a good knowledge of the behavior of various parts of the device. This paper deals with three main topics: First, the electrical characteristics of implanted diodes are described, and their variations as a function of annealing temperature lead to a physical model taking into account the anisotropy of impurity concentration gradients. Second, experimental conditions before, during, and after implantation are shown to have a strong influence on the quality of the final device, particularly on the value of the reverse leakage current. Third, effects of bombardment on silicon dioxide layers are studied. It is found that recovery of the layers is generally complete after a 300°C annealing. Contributions of these various parameters to the overall electrical characteristics of ion-implanted self-aligned MOS transistors are finally considered. Substantial increase in the maximum oscillation frequency and reduction of the active surface areas of the device are the most evident advantages of using ion-implantation technology. (auth)

37678 ELECTRICAL BEHAVIOUR OF ABRUPT ION IMPLANTED AND DIFFUSED P^+N JUNCTIONS. Stephen, J.; Grimshaw, J. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Radiat. Eff.; 7: 73-85(Jan 1971).

Results are reported of measurements of the properties of

diodes formed by ion implantation, and for comparison boron-diffused P^+N diodes of similar area close by on the same chip. The four Group III acceptor impurities were implanted separately to a dose of 5×10^{15} ions/cm^2 at room temperature into similar samples of suitably masked silicon. Boron ions were also implanted at liquid nitrogen temperature and 450°C. Annealing was limited to a maximum temperature of 550°C. Measurements were made of sheet resistance, forward and reverse I–V characteristics (from 10^{-9} A/cm^2), reverse breakdown voltage, noise, minority carrier storage time, and junction series resistance. The bulk properties of boron-implanted diodes were found to be reproducible. The introduction of recombination centers by implantation is the major factor influencing variation in these properties between one implantation condition and another. Changes in surface oxide conditions probably affect reverse leakage currents and breakdown voltages. The properties of boron-implanted diodes are considered suitable for applications such as the MOSFET, and are superior to those of the Al, Ga, and In-implanted diodes. (auth)

37679 EFFECT OF ION-IMPLANTATION INTO THERMAL SiO_2-FILMS ON SODIUM ION DRIFT. Fritzsche, C.; Goetzberger, A.; Axmann, A.; Rothemund, W.; Sixt, G. (Institut fuer Angewandte Festkoerperphysik, Freiburg i. B.). Radiat. Eff.; 7: 87-93(Jan 1971).

Sodium and nitrogen were implanted at 20 keV and 80 keV into MOS capacitors. The influence of the implantation on sodium ion drift was studied by temperature bias treatments combined with capacitance–voltage measurements. An ion trapping effect at the electrode is observed which is strongly enhanced by 20-keV implantations and the mobile ion content can be completely depleted by repeated drift treatments. 80-keV implantations seem to stabilize the oxide with respect to sodium ion migration but cause traps which exchange carriers with the silicon. All these effects are not attributed to the implanted ions but to the radiation damage. (auth)

37680 ION-IMPLANTED PLANAR RESISTORS. Rosendal, Knud (Technical Univ., Lyngby, Denmark). Radiat. Eff.; 7: 95-100(Jan 1971).

Boron ions have been implanted into silicon to form p-type planar resistors. The resistors have boron-diffused contacts and the energetic ions were implanted through an approximately 0.2-micron-thick thermally grown SiO_2 film, on top of which a pattern was etched in an evaporated aluminum layer to define the areas to be implanted. The ion doses were in the range 10^{12} to 10^{15} cm^{-2} with ion energies 120 and 200 keV. All implantations were performed at room temperature and the annealing took place for 15 min in a nitrogen ambient in the temperature range 300 to 950°C. Among the results of the investigations are the obtainable range of sheet resistivities, the large-area-homogeneity and the temperature coefficient of resistance (TCR) as a function of the above parameters. (auth)

37681 IMPROVEMENT TO THE THIRD ORDER OF THE OPTICAL PROPERTIES OF MAGNETIC SPECTROMETERS. Bounin, P. (Centre National de al Recherche Scientifique, Paris). Nucl. Instrum. Methods; 94: No. 1, 77-85(1971). (In French).

Optical properties of magnetic spectrometers may be improved by taking into consideration the third-order term in the field configuration. This can be illustrated with a ray-tracing program. The study is devoted to the case of the so-called magic spectrometer, but it can be generalized. (auth)

37682 EXAMPLES OF THE APPLICATION OF THE FERMAT PRINCIPLE TO THE MAGNETIC SPECTROMETER. Bounin, P. (CNRS, Paris). Nucl. Instrum. Methods; 94: No. 1, 73-6(1971). (In French).

We have already shown how the optical properties of some magnetic spectrometers can be explained with the help of Fermat's principle. Two other examples of application are given. (auth)

37683 MAGNETIC FIELD STABILIZER BASED ON PROTON RESONANCE IN FLOWING WATER. Boving, R. (Univ., Louvain, Belgium). Nucl. Instrum. Methods; 94: No. 1, 61-71 (1971).

A two-directional double focussing beta spectrometer has been developed and constructed for on-line measurements. The magnetic induction in the spectrometer airgap is continuously variable between 1.5×10^{-3}T and 5×10^{-2}T. Measurement and stabilisation of this induction is realized by means of proton resonance in flowing water. Water is polarized in the airgap of an electromagnet (induction: 1.8 T); from the polarizing magnet it is rapidly driven into the resonance absorption coil, situated in the spectrometer airgap. An electronic control unit, driven by the proton resonance signal, provides a long term relative induction stability better than 10^{-5} and a reproducibility of at least 5×10^{-6}. (auth)

37684 QUADRUPOLE LENS REACTION PRODUCTS SPECTROMETER SYSTEM. Green, R. E. L.; Lind, D. A. (Univ. of Colorado, Boulder). Nucl. Instrum. Methods; 94: No. 1, 93-105(1971).

The use of the momentum aberration inherent in magnetic quadrupole lenses is studied as the basis for constructing low resolution nuclear reaction product spectrometers and magnetic rigidity band pass filters. An operational system utilizing a quadrupole doublet is described. The system provides a solid angle of 1.8 mrs, a variable momentum acceptance range up to a mass energy product of 100 amu MeV, and a range of laboratory scattering angles from 0 to ±80°. Data from representative experiments taken with the system are presented to demonstrate its capabilities. (auth)

37685 NUCLEAR MAGNETIC RESONANCE AT HIGH RESOLUTION. Taquin, J. (Paris Univ., Orsay, France). Method. Phys. Anal.; 7: No. 1, 3-9(Mar 1971). (In French).

An important improvement in high resolution NMR was obtained using superconducting coils to increase the main magnetic field. It was, however necessary to maintain field homogeneity. A few technical details about the construction of a spectrometer operating at 240 MHz are given emphasizing the different coils used to achieve homogeneity. A few examples are given of the advantages of increasing the field in the study of spectra. (France)

37686 APPARATUS TO DETERMINE THE OPTICAL PROPERTIES IN THE EXTREME ULTRAVIOLET OF FILMS WHICH ARE EVAPORATED AND STORED IN ULTRA HIGH VACUUM (10^{-10} TORR). Daude, A.; Robin, S. (Univ., Rennes, France). Nouv. Rev. Opt. Appl.; 2: No. 1, 57-62(Jan-Feb 1971). (In French).

A system for displaying simulated post-detonation "effects" of a nuclear device on a geographical map is described. The system comprises a geographical plotter and a multiplicity of analog computers for storing the functional relationships between yield characteristics of a nuclear device, manner of detonation, and environmental conditions on one hand, and the "effects" resulting from detonation on the other. In response to input signal data corresponding to the variables of these functional relationships, the analog computers issue output signals representative of the associated magnitudes and ranges of the "effects" and such range signals are simultaneously utilized to project and superimpose figures onto a geographical map by means of the plotter. The area on the map encompassed by each figure indicates the geographical extent subjected to the corresponding simulated nuclear detonation "effect." (auth)

37687 NEW TECHNIQUE FOR NEUTRON DIFFRACTION. USE OF WHITE RADIATION. Hubbard, C. R.; Quicksall, C. O.; Jacobson, R. A. (Ames Lab., Iowa). Nucl. Instrum. Methods; 94: No. 1, 185-6(1971).

A new diffraction method has been developed which uses a white neutron beam. With this method the efficiency of data collection is enhanced approximately one hundred fold. (auth)

37688 WEAPONS EFFECT DISPLAY SYSTEM. Berndt, Carl W.; Reinecker, Frederick Jr.; Downing, Willis G. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,558,865. 26 Jan 1971. Filed 31 Mar 1967.

The optical properties of thin films depend chiefly upon the surrounding conditions of preparation and conservation. An apparatus permitting the determination of optical constants of materials evaporated in ultra high vacuum is described, a device of stockpiling and displacement of the samples allows to conserve and study 40 samples without exposing to air the different chambers. The thicknesses were measured during the evaporation by means of a piezoelectric quartz, the composition of the residual atmosphere being controlled by a quadrupolar gas analyser. Since no window is used between the source and the reflector, the apparatus can be used for any spectral region but principally it is realized for far ultraviolet. The receptor used at present is a Bendix M 306 photomultiplier without any window. The apparatus enables the measurement of transmittance and reflectance for the angles of incidence varying between 15 and 70° with a good precision. Some results of the measurements carried out with this apparatus for Al, Mg, and MgF_2 are given. (auth) (France)

37689 RADIATION COLLIMATOR. Broquet, Claude (to l'Atome Industriel SA). French Patent 2,038,757. 28 Dec 1970. Filed 28 Mar 1969. (In French).

The invention concerns an x, α, β, and γ radiation collimator which enables parallax errors and the contribution due to diffuse

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radiation to be reduced without appreciably diminishing the intensity of the beam reaching the detector. This collimator consists of a tubular mounting containing foils of a material having a high coefficient of absorption for the radiation considered, which encircles a central passage. (France)

37690 BIOLOGICAL SHIELDING DEVICE FOR AN APPARATUS USED IN NEUTRON CRYSTALLOGRAPHY WITH RADIOACTIVE SAMPLES. Englander, Marcel; Taverne, Henri (to Commissariat a l'Energie Atomique). French Patent 2,029,188. 5 Oct 1970. Filed 16 Jan 1969. (In French).

A biological shielding device for an apparatus used in neutron crystallography with radioactive samples is presented. The sample, held by a sample-holder rigidly locked with a goniometer, is placed inside the central channel of a cylinder made of reinforced lead. An empty sector opening into a quarter of the section and a radial horizontal channel with a rectangular cross section whose length is equal to the radius of the cylinder are arranged at half the height of the cylinder. The angle which the axis of the channel makes with the inner bisecting line of the sector is 135°. An outer tunnel made of lead extends the channel. The cylinder rotates about the axis of the goniometer with an arm rigidly locked to the spectrometer support. The cylinder is placed inside a semicircular lead shielding, which has a rectangular channel facing the fission chamber of the spectrometer. The upper shielding is provided by a lead castle. (France)

37691 RATE DIVIDERS AND APPLICATIONS IN NUCLEAR INSTRUMENTATION. Taylor, D.; Bhatt, S. J.; Rao, D. N. (Univ. of Strathclyde, Scotland). Nucl. Instrum. Methods; 93: No. 3, 585-7(1971).

The binary rate divider used for regular rate processing is described, and some potential applications are reviewed including its use for automatic correction of deadtime losses. (W.H.K.)

37692 COOLING DEVICE EMPLOYING THERMOELECTRIC REFRIGERATORS. Calligaris, F.; Ciuti, P. (Univ., Trieste, Italy). Nucl. Instrum. Methods; 93: No. 3, 577-80(1971).

A cooling device employing a two-stage thermoelectric cascade is studied. An electrical circuit feeding and controlling a Peltier refrigerator is described. The apparatus may be useful in some nuclear instrumentation problems. (auth)

37693 COMPENSATED LEADING EDGE TIMING CIRCUIT. Karlsson, L. (Royal Veterinary and Agricultural Univ., Copenhagen). Nucl. Instrum. Methods; 93: No. 3, 563-70(1971).

A fast leading edge discriminator developed for time measurements in nuclear physics is presented. It differs from the well known leading edge discriminator because the working point of the tunnel diode is selected for each pulse before the pulse arrives to the discriminating tunnel diode. The threshold is continuously variable between 25 mV and 1 V. The timing output signals are a positive and a negative pulse each with an amplitude of 1.5 V into 50 Ω and a rise-time of about 2 ns. (auth)

37694 ELECTRIC INSULATION FOR INCORE USE. Keil, D. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Kerntechnik; 12: 480-1(Nov 1970). (In German and English).

A method is described for manufacturing electrically insulated leads and components particularly suitable for use in reactors or in other intense nuclear radiation fields. The method was used for manufacturing an electrically insulated sample holder for low-temperature irradiation experiments in a reactor core. Some of the typical features are high resistance against irradiation, low induced radioactivity after short decay times, usability even at extremely low temperatures, and protection of the aluminum by the oxide layer against corrosion. (auth)

37695 ELECTROCHEMICAL CARBON METER FOR USE IN SODIUM. Salzano, F. J. (Brookhaven National Lab., Upton, N. Y.); Newman, L.; Hobdell, M. R. Nucl. Technol.; 10: No. 3, 335-47(Mar 1971).

The feasibility of an electrochemical carbon meter which measures the chemical activity of carbon in sodium at temperatures from 600° to 700°C has been demonstrated. The meter is based on a cell with $Na_2CO_3-LiCO_3$ electrolyte and has been shown to respond to the addition of various carbonaceous reagents which were added to the sodium, especially carburized iron. The chemical activity of carbon in equilibrium with a 347 stainless steel–sodium system has been measured. The meter can be used to indicate when carburizing or decarburizing conditions exist in the sodium. The solubility of carbon in sodium has been determined with the carbon meter. (auth)

37696 CALCULATION OF COLLIMATOR PENETRATION EFFECTS. Simons, H. A. B. (Royal Free Hospital, London). Phys. Med. Biol.; 16: 329-33(Apr 1971).

The results of two papers by Bell, Spiers and Johnston (Phys. Med. Biol., 15: 47(1970)) and Simons (Phys. Med. Biol., 15: 57 (1970)) are compared by interchanging the data and methods of calculation. Penetration factors were calculated for a cylindrical collimating hole of radius 8 mm, length 50 mm, with source in a plane 50 mm above entrance pupil. (UK)

37697 REPORT OF A FAILURE OF A COMMERCIAL X-RAY DIFFRACTION SHUTTER STATUS SYSTEM. Lamastra, A.; McDonald, D. J. Health Phys.; 20: No. 6, 639-40(Jun 1971).

Shutter binding and accidental exposure were reported during use of a Philips Norelco diffractometer with a Norelco 12054B tube shield. Manually produced binding during subsequent tests indicated potential design problems in addition to screw burrs. Notes are made of alterations carried out to design and procedure, and possible improvements to similar safety devices are briefly discussed. (UK)

37698 IMPROVEMENTS IN OR RELATING TO RADIOACTIVE TIME BASES USING MULTICELLULAR DETECTORS. Koehler, Dale Roland (to Bulova Watch Co., Inc.). British Patent 1,230,341. 28 Apr 1971. Filed 21 Mar 1969.

A radioactive timekeeping standard is described that employs a multicellular solid-state radiation detector assembly including an array of radiation-sensitive semiconductor cells, an equal number of unidirectional elements and an array of "islands" of an α-emitter deposited on a backing having protective shielding properties. The α-emitter may be ^{238}U, ^{235}U, ^{237}Np or ^{239}Pu. The semiconductor cells may be of the surface-barrier or diffused-junction type, and the unidirectional elements may be n–p diodes. Full descriptional details are given, including a microcircuit layout and a number of geometrical alternatives. (UK)

37699 IMPROVEMENTS IN AND RELATING TO SAMPLING DEVICES. Garnier, Andre. British Patent 1,225,107. 17 Mar 1971. Priority date 13 Sep 1968, France.

A portable apparatus for carrying out continuous sampling in an atmosphere contaminated by radioactive aerosols is described; the device may be used to determine, by examining and analyzing the substances collected on a filter associated with the apparatus, the degree of contamination to which an operator who has worked in this atmosphere for a given period has been subjected. The device has a small bellows, driven by a battery-powered electric motor, which draws air into the apparatus. The volume sampled is equivalent to approximately 1/4 of the user's respiration; hence, valid extrapolation is possible. (R.W.R.)

37700 SAMPLING APPARATUS. Ballet, Paul; Dewulf, Roger (to Commissariat a l'Energie Atomique). British Patent 1,224,522. 10 Mar 1971. Priority date 1 Dec 1967, France.

A device for taking samples from a stream of corrosive or radioactive liquid, possibly at high temperature, is described. The sampling process is relatively simple, and can be automated and operated by remote control. (R.W.R.)

37701 PLURAL BEAM MASS SPECTROMETER FOR CONDUCTING HIGH AND LOW RESOLUTION STUDIES. Powers, Patrick (to Associated Electrical Industries Ltd.). U. S. Patent 3,573,453. 6 Apr 1971. Filed 12 May 1967.

A mass spectrometer is provided with one or two ion sources and two collectors. Slit structure is associated with each ion beam and the mass spectral range of one beam can be compared with that of the other beam. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 37577 and 38563.

37702 EFFECTS OF PROTON RADIATION ON CAPACITANCE/VOLTAGE CHARACTERISTICS OF M.O.S. CAPACITORS. Card, H. C.; Kao, K. C. (Univ. of Manitoba, Winnipeg, Can.). Electron. Lett.; 7: No. 10, 262-420(May 1971).

The capacitance/bias-voltage characteristics of metal oxide-semiconductor capacitors were measured before and after irradiation with 25 MeV protons under various bombardment voltages applied to the gate during irradiation. The radiation-induced charge carriers were trapped in a localized region that extended approximately 300 Å into the oxide layer from the $Si-SiO_2$ interface. The induced space-charge density showed an exponential dependence on the radiation dose and a linear dependence on the bombardment voltage. The effects were independent of the dose rate and appeared to approach saturation for a dose of 3.5×10^{13} protons/cm^2 with an effective bombardment voltage of 5 V. (auth) (UK)

37703 PECULIAR BEHAVIOR OF p-SUBSTRATUM MOS TRANSISTORS IN AN IONIZING RADIATION FLUX. Therez, Francis; Buxo, Jean; Esteve, Daniel (CNRS, Toulouse). Compt. Rend., Ser B; 272: No. 15, 889-92(14 Apr 1971). (In French).

The experimental conditions necessary for negative charges to appear in the silica of an MOS structure subjected to an ionizing radiation are given. An interpretation is proposed, based on the ability of silicon to inject electrons into the silica. (auth) (France)

37704 SILICON MICRO-HALL DEVICE: DESIGN, FABRICATION, AND APPLICATIONS. Colclaser, Arthur. Albuquerque, N. Mex.; Univ. of New Mexico (1970). 207p. University Microfilms Order No. 71-12,769.

Thesis.

A family of silicon devices, the micro-Hall devices, are described. These include the diffused, diffused-epitaxial, isolation-diffused-epitaxial, mesa-epitaxial, and silicon-on-sapphire isolation-diffused structures. The design and fabrication of these devices are presented in complete detail. The theory of the Hall effect and its applications to the theory of fast neutron displacement damage to silicon are presented. A quantitative model of radiation damage in the form of spherical intrinsic voids representing the damage clusters is described. Three applications of the isolation-diffused-epitaxial silicon micro-Hall device are discussed. The first of these, the evaluation of epitaxial silicon, has three features which are different from the customary four-point probe technique. The fabrication of the micro-Hall devices requires all of the processes in the manufacture of junction-isolated integrated circuits. These high-temperature processes cause changes in the electrical properties of the material. Using the micro-Hall device method permits determination of the properties of the material after processing rather than before. By evaluating an entire wafer with micro-Hall devices, it is possible to determine the variations of material properties as a function of position across the wafer. Including the micro-Hall device pattern as a test pattern on an integrated circuit mask set permits evaluation of the actual material used in an integrated circuit wafer. Three wafers, one of which is silicon-on-sapphire, were evaluated by the micro-Hall device method and compared to four-point probe measurements of the same material. The same devices used for epitaxial evaluation were exposed to fast-neutron bombardment in the Sandia Annular Core Pulse Reactor, and re-evaluated to determine the effects of room temperature stable displacement damage on the electrical properties of the material. These effects were compared to the results of similar experiments conducted on bulk silicon material with the same initial resistivity. The damage effects to the epitaxial material were found to be similar to those previously reported in bulk material. The characteristics of the silicon micro-Hall device as magnetic sensor are presented. This application requires a careful compensation for voltages due to the misalignment of the measuring arms. (Diss. Abstr. Int., B)

37705 INFLUENCE OF INJECTION RATE ON CARRIER LIFETIME DEGRADATION IN p-TYPE SILICON IRRADIATED BY 4.5 MeV ELECTRONS. Bielle-Daspet, D.; Pouget, M. (Centre d'Etude Spatiale des Rayonnements, Toulouse). Nucl. Instrum. Methods; 93: No. 3, 413-15(1971).

The lifetime degradation constant is studied versus carrier injection rate for several samples. Values at low and high injection rates are given in abacus form and results may be applied to predict device degradation under radiation stress. (auth)

37706 RADIATION DAMAGE TO SEMICONDUCTOR COMPONENTS IN SPACE FLIGHT MISSIONS. Baeuerlein, Rudolf (Siemens AG, Erlangen, Ger.). Raumfahrtforschung; 15: No. 2, 45-51(Mar-Apr 1971). (In German).

Electronic components of spacecraft systems and power supplies are exposed to high-energy electrons and protons from the Van Allen Belt and cosmic radiation sources during space missions. Semiconductor components are particularly susceptible to changes in their electric parameters due to this irradiation. Information is presented on the damage sustained by planar-junction transistors, rectifier diodes, zener diodes, tunnel diodes, charge-storage diodes, and solar cells due to electron and proton irradiation. Laboratory irradiation tests can be used for radiation-damage prediction during space flights. The basic physics of the phenomena of radiation damage are discussed with special emphasis being placed on the ionization damage to planar-junction transistors. Mention is also made of the possibility of developing radiation-resistant devices. (auth)

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LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 37403 and 37826.

Basic Processes

Refer also to abstracts 37833 and 37866.

37707 (CU–3835-3) TRITIATION OF PROTEIN HORMONES. Progress Report, 1970–1971. (Columbia Univ., New York). 39p. Dep. NTIS.

Methods for the preparation of ^{3}H-ACTH with high specific activity are described. Data are included on the purification, chromatographic characterization, and immunological stability of the labeled ACTH. (C.H.)

37708 DOWEX RESIN LABELED WITH ^{113m}In FOR LUNG SCANNING. PRELIMINARY REPORT. Erjavec, Marjan; Jenko, M.; Ravnik, V. (Inst. of Oncology, Ljubljana, Yugoslavia). Radiol. Diagn.; 11: 791-2(1970).

Sterile microsieved Dowex 50W-X-8 cation exchange resins (50 to 60 microns in diameter) were mixed with ^{113m}In as eluted from the sterile generator column. The labeled 50–50 micron fractions gave good results when used for scanning blood circulation in the lungs. (C.H.)

37709 NEW COMPLEX OF ^{99m}Tc FOR SKELETAL IMAGING. Subramanian, G.; McAfee, J. G. (Upstate Medical Center, Syracuse, N. Y.). Radiology; 99: 192-6(Apr 1971).

A metabolizable new complex of ^{99m}Tc, formulated using tripolyphosphate and stannous chloride, shows considerable promise as a skeletal localizing agent from preliminary animal tissue radioassay and imaging studies. Callus was delineated well from normal bone in experimental fractures using this agent. The physical characteristics and relative tissue concentrations compare favorably to those of other short-lived bone-seeking radionuclides. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 37742, 37745, 37748, 37769–37772, 37776, 37778, 37780, 37789, 37846, 37861, 37867, and 37899.

37710 (A/CONF.49/P-81) EVALUATION OF LONGTERM EFFECTS OF EXPOSURE TO INTERNALLY DEPOSITED RADIONUCLIDES. Bustad, L. K. (California Univ., Davis. Radiobiology Lab.); Mays, C. W. (Utah Univ., Salt Lake City; Goldman, Marvin; Rosenblatt, L. S. (California Univ., Davis); Hetherington, N. W. (California Univ., Livermore. Lawrence Radiation Lab.); Bair, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.); McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.); Richmond, C. R. (Atomic Energy Commission, Washington, D. C.); Rowland, R. E. (Argonne National Lab., Ill.). Sep 1971. 19p. (CONF-710901-18). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Although the late effects of low-level exposure to internal emitters are dependent on the physical and metabolic behavior of the radionuclide, they are quantitatively and qualitatively similar to the effects from partial or whole-body external irradiation. Dose-response relationships are summarized for a variety of exposure regimens of bone-seeking radionuclides, radioiodine, and tritium in man, swine, rodents, dogs, and nonhuman primates at the University of California, Davis; University of Utah; Argonne National Laboratory; Battelle–Northwest; Lovelace Foundation for Medical Education and Research; University of Munich; Swedish National Defense Research Institute; and Biophysics Institute, Moscow, USSR. No bone tumors have been seen following radium injections in any dog receiving <~500 rads to the skeleton over an 11-yr exposure nor in man with <1000 rads over a 40- to 50-yr exposure. These data suggest a sigmoid dose response like that for the β emitter ^{90}Sr, which features a low-risk region. No radiation-induced late deleterious effects from ^{90}Sr in dogs have been seen at levels up to 500 rads in 10 yr. Even at ^{90}Sr levels with a high risk for tumor induction, no effects on reproduction have been demonstrated. Survival rates at all tested levels are comparable to controls when corrected for radiogenic tumor induction. At the same dosage patterns and durations, ^{3}H, ^{137}Cs, and other radionuclides with total-body distribution elicit the same dose-effect responses as x- or γ-radiation and present no unique hazards. Cumulative incidence rates for ^{90}Sr- and ^{226}Ra-induced bone and hematopoietic tumors were fit using a logistic model. Results were extrapolated to near-background doses; the curvilinear model fit the data reasonably well and will be applied to ^{131}I, ^{224}Ra, and inhaled ^{239}Pu. The model suggests that a practical threshold obtains when the rate of tissue injury appears to be less than the repair capability during the life of the cells at risk. The spatial and temporal relationship of dose rate and cell distribution pattern appears to be the major determinant in the evaluation of radionuclide hazard. (auth)

37711 (ANL–7770, pp 149-56) MODIFICATION OF RADIATION EFFECTS. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

Progress is reported on the following studies: determination of ^{239}Pu and ^{241}Am in animal tissues by liquid scintillation spectrometry; metabolic and therapeutic studies of plutonium and americium; biochemistry and ion binding of connective tissue; effects of non-irradiated, homogenized protoplasm on supralethally x-irradiated amoebae; ultrastructure of spermatozoa from the American oyster, Crassostrea virginica; ultrastructure of oocytes from Crassostrea virginica; and treatment of x- or uv-irradiated amoebae with injections of homogenate made from nonirradiated amoebae at 2°C. (H.L.W.)

37712 (BNWL–1551(Pt.2), pp 65-9) INTERNAL DEPOSITIONS OF RADIONUCLIDES IN MAN. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

Methods for the localization of inhaled $^{147}Pm\ O_3$ in man were investigated. Results are reported from studies on the tissue distribution of injected ^{147}Pm and ^{147}Sm in rats. No gross differences in the metabolism of Pm and Sm were observed. Efforts to produce Sm–Pm oxide aerosols for use in inhalation tests are reported. The feasibility of using whole-body counters for estimating the deposition of ^{147}Pm in man was investigated. Respiratory tract models used in studies of mechanisms influencing the deposition of radon daughter α particles in human tracheobronchial epithelial cells are described. (C.H.)

37713 (BNWL–1551(Pt.2), pp 72-9) NUCLEAR TECHNIQUES IN MEDICAL SCIENCE. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

Methods for in vivo neutron activation analysis were developed for measurement of total-body calcium in patients suffering from metabolic bone diseases. Measurements of total-body, exchangeable, and non-exchangeable sodium were made on five normal adults using a combination of in vivo activation analysis and isotopic dilution. The feasibility of using activation analysis for measurements of total-body phosphorus was tested in mice and good agreement was found in values determined by activation and chemical methods. A dual-window proportional detector was designed for the direct measurement of ^{55}Fe in blood and other liquid samples. Scintillation probes were developed for the measurement of Pu deposition in bronchial lymph nodes. (C.H.)

37714 (BNWL-SA–3711) ACCUMULATION AND RETENTION OF TRITIUM (TRITIATED WATER) IN EMBRYONIC AND LARVAL FISH, AND RADIATION EFFECT. Strand, J. A.; Templeton, W. L.; Tangen, E. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1971]. Contract AT(45-1)-1830. 20p. (CONF-710501–16). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (19 May 1971).

Eggs of rainbow trout, Salmo gairdneri, were spawned artificially in the laboratory and exposed to 0.01, 0.1, 1.0 and 10.0 uc/ml tritium-H_3 (biological grade) contaminated spring water. Rearing throughout embryogenesis, 25 days at 10.5 ± .5°C, was facilitated within a recirculating drip incubation system. Water and embryos were sampled at intervals to ascertain the time necessary to reach equilibrium. After 20 days exposure, selected lots of embryos were removed to inactive free-flowing water to study retention and turnover components. Combustion of samples for liquid scintillation counting was accomplished using Model 300 Tri-Carb Sample Oxidizer. Distinction between volatile or body-water tritium-H_3 and non-volatile or bound tritium-H_3 was emphasized. A rapid uptake of tritium-H_3 during the first 1 to 2 days was indicated for all three concentrations, followed during the ensuing 27 to 28 days of

exposure by maintenance of equilibrium levels. The bound tritium-H_3 fraction accounted for approximately 20 percent of the total level in each egg, a level not exceeded as measured over the duration of exposure. Both volatile and bound fractions, after transfer to free-flowing water, elute rapidly with estimated half-times of ~1.0 and ~2 hours, respectively. A slower component of the volatile fractions persists for ~17 days, as determined in hatched fry. The slow component of the bound fraction, for comparison, persists at approximately 0.6 percent of the initial bound equilibrium level at 17 days. Even after six months, in juveniles, a trace but measurable level of this component was detected. The effects of each treatment on embryogenesis were assessed in terms of the proportions of eggs hatching and the numbers of obviously abnormal larvae produced. Selected behavioral and physiological tests were applied to detect sub-lethal effect. Preliminary consideration of all data indicated that no significant degree of detriment resulted from exposure at these levels during embryogenesis. (auth)

37715 (CONF-690527–, Paper 2) THE CONCENTRATION AND DISTRIBUTION OF INACTIVE ISOTOPES AS TRACE POLLUTANTS IN MARINE AND FRESH WATER ENVIRONMENTS, AND THE EFFECT OF A CALCIUM INJECTION INTO A LAKE. Feldt, Werner (Bundesforschungsanstalt fuer Fischerei, Hamburg (West Germany). Isotopenlaboratorium). 15p.

From fifth R.I.S. symposium; Helsinki, Finland (19 May 1969). In Radioactivity in Scandinavia.

The effects of Ca injection into a freshwater lake on the uptake of ^{90}Sr by fish was investigated. Twenty tons of $CaCO_3$ were injected into the lake, and the same amount was added a year later. Before the Ca was added the ^{90}Sr content in water was 5 pCi/l and in fish was 120 pCi/gm Ca. The ^{90}Sr activity in both fish and water decreased to the same extent that the Ca content was raised. Results are also reported from measurements of trace elements in deep sea organisms and the uptake of stable Sr in freshwater and sea organisms. (C.H.)

37716 (CONF-690527–, Paper 4) STUDIES ON THE DISTRIBUTION OF ^{203}Hg-LABELLED METHYL MERCURY AND PHENYL MERCURY IN PIKE. Ohmomo, Y. (National Inst. of Radiological Sciences, [Tokyo] (Japan)); Miettinen, V.; Blankenstein, E.; Tillander, M.; Rissanen, K.; Miettinen, J. K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 17p.

From fifth R.I.S. symposium; Helsinki, Finland (19 May 1969). In Radioactivity in Scandinavia.

The uptake and tissue distribution of ^{203}Hg by fish was studied following the oral administration of ^{203}Hg-methyl mercury, ^{203}Hg-phenyl mercury on protein-bound ^{203}Hg, to fish held in a net placed in the Gulf of Finland. Many of the fish died about three weeks following the first intake of Hg. (C.H.)

37717 (CONF-701126–1) MATERNAL-FETAL TRANSFER OF IRON IN SHEEP. Dyer, N.; Raye, J.; Gutberlet, R.; Stahlman, M.; Brill, A. B. (Vanderbilt Univ., Nashville, Tenn. School of Medicine). [nd]. Contract AT(40-1)-2401. 15p. Dep. NTIS.

From eleventh annual meeting of southern society for pediatric research; New Orleans, La. (20 Nov 1970).

The bi-directional maternal-fetal transport and the fetal utilization of iron for six sheep were measured late in pregnancy. The placental transfer and fetal tissue utilization of iron are lower for sheep than for other mammals. Only one-half of one percent of the iron tracer given the ewe appeared in the fetus. There was no detectable iron transport to the ewe from the fetus. A significant time delay between the incorporation of the fetal and administered iron tracers into fetal blood was found. An investigation of this time delay may provide a better understanding of placental physiology for iron transport. Using the modified sheep data, the total fetal radiation dose to the 34 to 36 week human fetus was estimated to be 25.1 rads per mCi. This is lower than the total fetal radiation dose of 35 to 40 rads per mCi for the 8 to 22 weeks human fetus that was estimated from therapeutic abortion studies. The fetal liver dose, which was estimated to be around 400 rads per mCi for the 8 to 22 week human fetus, is only about one-sixth as much for the 34 to 36 week human fetus. The observed malignancies in the children exposed to ^{59}Fe in utero were only found in those exposed early in pregnancy. The lack of observed malignancies in the children exposed in the later gestational stages is consistent with the lower radiation doses estimated for these children. (auth)

37718 (EUR–4527) MOVEMENT OF CERTAIN ISOTOPES IN ANIMALS AND MAN. Annual Report, 1969. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 6 Jul 1970. 44p. (In French). Dep. NTIS (U. S. Sales Only). EUR FF 6,65.

During 1969 studies tended in two main directions, viz. the metabolism of elements of valency III and IV inhaled in droplet form, and research on mechanisms conditioning lung clearance. In the first sphere, the work showed that the conclusions drawn from local administration could be extrapolated to aerosols, but that the inhaled radioelement had a tendency to a more pronounced osteotrophy. Moreover, with regard to the lungs, the kinetics of penetration into the organism largely depend on physico-chemical conditions of the solution from which the aerosol was derived. In the second sphere, research was conducted on the possibility of disturbing the lung clearance. If an acute irradiation only has a slight effect, chronic irradiation by alpha intra-cellular emitters blocks the lung clearance. The same is true of toxic dust (quartz) or inert dusts (coal) as soon as the weight of dust in the alveolus exceeds 1 mg. Isotopes studied were ^{241}Am, ^{144}Ce, ^{242}Cm, ^{140}La, ^{177}Lu, ^{239}Pu, and ^{46}Sc. (H.L.W.)

37719 (EUR–4612, pp 187-204) BINDING OF TRANSPLUTONIUM ELEMENTS TO PROTEINS OF BONE. Taylor, D. M.; Chipperfield, A. R. (Institute of Cancer Research, Sutton (England). Surrey Branch).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Plutonium and americium are bound by other glycoproteins in bone, but only the chondroitin sulphate-protein complex binds these elements as strongly as bone sialoprotein (BSP). The binding of plutonium and americium to BSP and chondroitin sulphate-protein appears to involve similar mechanisms. The two most abundant components of bone are collagen, which does not bind significant amounts of plutonium or americium and bone mineral. The relative importance of the mineral in binding plutonium and americium appears to differ for the two elements. In the presence of citrate americium deposited more readily than plutonium on bone mineral, and the Pu–BSP complex was sufficiently stable to prevent coprecipitation of plutonium with calcium phosphate. Although the overall deposition of plutonium and americium in bone is grossly similar, these elements differ in that plutonium deposits preferentially on endosteal surfaces and plutonium-239 is more effective than americium-241 in inducing bone tumors. While the present observations suggest that plutonium, americium and curium bind to glycoproteins in vitro, it seems likely that in vivo glycoprotein binding of plutonium may be of greater importance in the localization of plutonium in or near the cells on the bone surface which are most susceptible to carcinogenic change. (auth)

37720 (EUR–4612, pp 205-22) SUBCELLULAR DISTRIBUTION OF AMERICIUM AND CURIUM IN RAT LIVER. Popplewell, D. S.; Boocock, G. (Atomic Weapons Research Establishment, Aldermaston (England)); Taylor, D. M.; Danpure, C. J. (Institute of Cancer Research, Sutton (England). Surrey Branch).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

The subcellular distribution of americium was studied in rat liver over a period of up to 26 days after intravenous injection of americium-241 in an essentially monomeric form as an ultrafiltered solution of the citrate complex. The subcellular distribution pattern is similar to that observed following the administration of monomeric plutonium, except that the rate of transfer of americium to the lysosomes appears to be more rapid than that of plutonium. Preliminary studies show an essentially similar subcellular distribution pattern for curium in rat liver. (auth)

37721 (RLO–2225-T-14-2) RADIONUCLIDES AND SELECTED TRACE ELEMENTS IN MARINE PROTEIN CONCENTRATES. Beasley, T. M.; Jokela, T. A.; Eagle, R. J. (Washington Univ., Seattle. Lab. of Radiation Ecology). [1970]. 15p. Dep. NTIS.

The concentrations of various trace elements and radionuclides were measured in marine protein concentrates prepared from surface feeding fishes. As with concentrates prepared from benthic fishes, the ^{210}Pb–^{210}Po pair are the most significant radionuclides present. Concentrations of stable Pb, Co, and Ag in certain concentrates are sufficiently high to contribute substantially to current intakes of these elements. (auth)

37722 (RLO–2227-T-8-2) RADIONUCLIDE CYCLING IN NATURAL POPULATIONS OF AMPHIBIANS. Annual Progress Report, June 16, 1970–June 15, 1971. Willis, David L. (Oregon State Univ., Corvallis. Dept. of General Science). Contract AT-(45-1)-2227. 7p. Dep. NTIS.

The newt, Taricha granulosa, was used for studies on uptake, retention, and tissue distribution of ^{51}Cr, ^{54}Mn, ^{59}Fe, and ^{181}W. Some newts were immersed in a radioactive solution for uptake studies simulating an environmental situation. Intraperitoneal injection was used as a method of introducing a well-defined

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amount of radioactivity into newts for whole-body retention and tissue distribution studies. Intestinal absorption rates were determined following feeding of small quantities of radionuclide solutions. Tables are presented to show effects of temperature on metabolism of radionuclides and long term biological half-lives in the newt. Experiments were begun on the effects of radionuclides on embryos and larvae of Rana pretiosa. (H.L.W.))

37723 NATURAL RaD(^{210}Pb) AND RaF(^{210}Po) IN YOUNG HUMAN BONES. Czegledi, P.; Dobrovolszky, A. (Inst. of Nutrition, Budapest). Isotopenpraxis; 6: 422-3(Nov 1970).

The natural RaD (^{210}Pb) concentration in man was determined from measurement of the RaF (^{210}Po), by a silver plating method, in bone samples obtained from autopsy of unexposed children aged 0 to 13 years. The average RaD concentration found in 25 bone samples was 0.070 pCi/g ash. The concentration was 10% higher in trabecular than in cortical bones. Average RaD concentration in ribs was 13% higher than that in femurs. Extremely high RaD contents were found in two caput femoris samples. Moreover an increase of RaD concentration according to age was found. (auth)

37724 EFFECT OF PHOSPHATE ON SERUM STRONTIUM. Chaudhuri, Tapan K.; Chaudhuri, Tuhin K.; Peterson, Richard E.; Christie, James H. (Univ. of Iowa, Iowa City). Proc. Soc. Exp. Biol. Med.; 137: No. 1, 1-4(May 1971).

The effect of phosphate on serum strontium and hence serum calcium is described. A possible mechanism of action is proposed. Organ distribution data in rats at different time intervals after iv injection of strontium and strontium with excess phosphate are presented. Studies show that, unlike the control animals, phosphate-treated animals had an initial large trapping of radiostrontium in liver, followed by its release into the circulation. Initial bone radioactivity was less in the phosphate-treated group than in the other. Within a 4-hr period, bone activity of the former gradually approached that of the latter. We propose that initial high activity in the liver was due to formation of strontium phosphate colloid and its removal by liver RE cells. This also explains the low initial activity in bone, as well as the lowering of serum strontium (or calcium), following phosphate therapy. The similarity of bone ^{90}Sr content in the two groups after 4 hr demonstrates the transitoriness of the altered body distribution of strontium and/or calcium which follows phosphate load. (auth)

37725 EFFECT OF PHOSPHATES ON STRONTIUM AND CALCIUM METABOLISM IN CONTROL, PARATHYROIDECTOMIZED AND PARATHORMONE-TREATED RATS. Gruden, Nevenka; Rabadija, L.; Kostial, Krista (Inst. for Medical Research, Zagreb). Arh. Hig. Rada Toksikol.; 19: 25-32(1968).

The influence of the phosphate content of the diet on strontium and calcium metabolism was studied in control, parathyroidectomized and parathormone treated rats after oral and intraperitoneal application of radioactive isotopes. It was shown that skeletal retention of radioactive calcium (^{45,47}Ca) and strontium (^{85}Sr) and the ^{85}Sr/^{45,47}Ca ratio depend upon the phosphate content in the diet as well as upon the route of radioactive isotope application. The effect of phosphates on calcium and strontium metabolism, however, does not depend upon the function of the parathyroid gland. In parathyroidectomized, parathormone-treated and control rats both the urinary elimination and gastrointestinal absorption of radiocalcium and radiostrontium are influenced by changes in dietary phosphates in the same way. (auth)

37726 LOCALIZATION OF RADIOCERIUM (^{144}Ce–^{144}Pr) IN COMPARISON WITH THE LOCALIZATION OF SOME HISTOCHEMICAL SUBSTANCES IN DENTAL TISSUES OF THE NEWBORN RAT. Beno, M.; Trnovec, T. (Research Inst. of Industrial Hygiene and Occupational Diseases, Bratislava). pp 203-6 of Proceedings of the 1st International Symposium on Nuclear Medicine. Prague; Charles University (1970). (CONF-690563-1).

From first international symposium on nuclear medicine; Karlovy Vary, Czechoslovakia (13 May 1969).

Newborn rats injected with $^{144}CeCl_3$(pH = 3) and ^{144}CeEDTA (pH = 7) were sacrificed four to six hours after injection. Histological sections of the undemineralized skull and teeth were autoradiographed. The adjacent sections were used for staining neutral, acid mucopolysaccharides and collagen. A similarity between the localization of radiocerium uptake, the localization of neutral acid mucopolysaccharides and collagen in dentinal layers was observed. The radioactive strip within the dentinal layers corresponded to the occurrence of glycogen granules within the odontoblasts. The extent of the localization of radiocerium was smaller than the extent of the respective localizations of neutral, acid mucopolysaccharides and collagen. This suggests that a direct early fixation of radiocerium on these substances is improbable. (auth)

37727 FATE OF SCHOONER FALLOUT RADIONUCLIDES INGESTED BY THE DAIRY COW. Potter, G. D.; Vattuone, G. M.; McIntyre, D. R. (Univ. of California, Livermore). Nucl. Technol.; 11: No. 3, 406-12(Jul 1971).

Debris from the Schooner Event, a Plowshare nuclear cratering experiment, was fed to a lactating cow and to a pregnant cow. Milk, urine, feces, and plasma levels of individual γ-emitting radionuclides were followed for six days in these cows. In addition, the radionuclides in the maternal and fetal tissues of the pregnant cow were studied. Radionuclides of tungsten, iodine, tellurium, barium, and rhenium were observed in milk. Those of arsenic, ruthenium, iodine, tellurium, tungsten, and rhenium were observed in urine. Maternal and fetal tissues contained radionuclides of iodine, barium, and tungsten, while maternal tissues contained these and radioarsenic as well. (auth)

Radiation Effects

Refer also to abstracts 37765, 37857, 37859, 37863, and 37896.

37728 (AECL–3860) BIOLOGY AND HEALTH PHYSICS DIVISION PROGRESS REPORT, OCTOBER 1–DECEMBER 31, 1970. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 84p. (PR-B–88). Dep. NTIS (U. S. Sales Only). AECL $2.00.

Progress is reported on the following research projects: role of enzymes in repair of radiation damage to DNA of Micrococcus radiodurans; radiation effects on DNA of Escherichia coli; number of viable mutants resulting from gamma irradiation of eggs of Dahlbominus; genetic control of radiosensitivity in Schizo saccharomyces pombe; radioinduced sterilization of Rhodnius; comparison of RNA molecules in animal cells by oligonucleotide analysis; preparation of lysis-sensitive yeast cells; a laser light scattering method for the study of ribosomal ribonucleic acid solutions; radioinduced degradation of DNA of E. coli; radioinduced leukemia in rats and mice; repair of DNA in irradiated Micrococcus radiodurans; effects of genetic strain and temperature on ultraviolet sensitivity of Schizosaccharomyces pombe; effects of radiomimetic chemicals on S. pombe; formation of deletion mutations of bacteriophage T4 by x rays and petit particles; radiation genetics of Dahlbominus; radioprotective effects of anoxia on Rhodnius; gamma radiation control of blackflies using the sterile male technique; effects of x radiation on fertility, litter size, and body weight of rat populations over 13 generations; low-dose effects in fish embryos from gamma-irradiated sperm; computer methods for the study of somatic and genetic harm in human populations; analysis of data from fallout ^{137}Cs and ^{90}Sr off-site monitoring; liquid effluent monitoring; tritium survey; determination of plutonium in effluent streams; uptake of ^{60}Co by edible plants; retention of iodine isotopes; fate of radionuclides in aquatic communities; Perch Lake basin studies on radioecology and underground movements of radionuclides; iron-phosphorus cycling in Upper Bass Lake; productivity studies in Maskinonge Lake; and radium studies. Progress in Health Physics consists of developments in neutron dosimetry with particular reference to criticality accident dosimetry, in radiation monitoring instrumentation, in personal dosimetry for beta and gamma radiation and in tritium health physics. Methods developed for health physics purposes were also applied to heavy water leak detection in reactor systems. Energy loss studies in biomolecules were begun with the building of a low energy electron scattering apparatus in which the angular distribution of electron beams which have passed through thin films of organic materials will be analyzed. A microscopic flyspot scanner for estimation of DNA content of single cells is being developed. (H.L.W.)

37729 (ANL–7770, pp 19-26) THEORETICAL BIOLOGY. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

Kinetics of band cells and metamyelocytes in bone marrow were studied. Equations are developed to represent "first in-first out" and "random exit" principles of cell behavior. Studies were conducted on the fall of intracellular particles through a rotating viscous fluid on a horizontal-axis clinostat. A computer code was developed for determining cell cycle parameters from measurements of the fraction of labeled mitoses. A method for the mathematical definition of rhythmic biological responses was developed using data on flower induction in darkness by Xanthium pennsylvanicum. Three strains of Escherichia coli were used in studies on uv-radioinduced damage to DNA; a binomial-sequential model of photoreactivation was developed. (H.L.W.)

37730 (CONF-701047–(Absts.)) EIGHTH ANNUAL MEETING OF THE GERMAN SOCIETY FOR BIOPHYSICS, OCTOBER 15–16, 1970. (Giessen Univ. (West Germany). Institut fuer Biophysik). 54p. (In English and German).

Presented are the effects of ionizing radiation on cells, tissues, and organisms. Also discussed are incorporation of various isotopes into the living organism. (H.B.G.)

37731 (INR–1246) RADIOACTIVE CONTAMINATIONS OF THE INSTITUTE OF NUCLEAR RESEARCH: CENTRE ZERAN AREA AND ITS ENVIRONMENT IN 1969. Gorberg, Zofia; Jaskulski, Jan (Institute of Nuclear Research, Warsaw (Poland)). 1970. 19p. (In Polish). Dep. NTIS (U. S. Sales Only).

The results of the radioactive contamination of the area and environment of the Institute of Nuclear Research–Centre Zerań carried out in 1969 are reported. The radioactivity of fallout, soil, grass, rye, waters and wastes, considered as typical materials of the Centre area and its surroundings, has been measured. These investigations chiefly concerned the influence of the work of Institute on the measured level of radioactivity. (auth)

37732 (NYO–2358-17) SUMMARY REPORT, 1965–1969. Borek, Ernest (Columbia Univ., New York). Contract AT-(30-1)-2358. 5p. Dep. NTIS.

Cross induction of prophage was shown to be mediated by a specific ultraviolet irradiation lesion that can be superimposed on the non-transferable inducing action of the mitomycins or x rays. Moreover, the effector can be photorestored in donors that have sustained lethal irreparable x radiation damage. Inhibitory effects of the following drugs were studied: actinomycin, azauracil, chloramphenicol, fluorouridine, hydroxyuridine, methyltryptophane, and puromycin. Studies on methylation of DNA showed that overmethylation of DNA occurred when net synthesis of the polymer was prevented by ultraviolet radiation. It was found that after induction of a lysogenic organism by ultraviolet or by heat, an inhibitor that specifically blocked the methylation of uracil to thymine appeared within the induced organism. After an interval the inhibitor either disappeared or a new enzyme impervious to the inhibitor was elaborated. During the phase of activity of this inhibitor, any newly formed t-RNA was aberrantly methylated. (H.L.W.)

37733 (ORO–3547-43) ROLE AND UTILIZATION OF ERYTHROPOIETIN IN STIMULATING ERYTHROPOIESIS. Progress Report. Lange, Robert D. (Tennessee Univ., Knoxville). [1970]. Contract AT(40-1)-3547. 21p. Dep. NTIS.

Progress is reported on the following research projects: use of antiserum to erythropoietin and renal erythropoietic factor to study erythroid colonies of mice by means of bone marrow transplants; electron microscope studies utilizing ferritin conjugated anti-erythropoietin serum; use of concentrated erythropoietin and anti-erythropoietin for studies of stem cell differentiation; studies on effects of hypoxia, irradiation, bone marrow transplantation, erythropoietin, renal erythropoietic factor, and alpha-2-globulin on erythropoiesis of mice; studies on mode of action of erythropoietin using vinblastine sulfate, hydroxyurea, anti-erythropoietin, and irradiation; induction of kidney tumors by estrogens in hamsters; and computer studies of the variables in the mouse assay technique for erythropoietin. (H.L.W.)

37734 (UCSF–10-P-2-133) RELATIONSHIP OF REPAIR REPLICATION TO STRAND REJOINING IN MAMMALIAN CELLS. Painter, Robert B. (California Univ., San Francisco. Lab. of Radiobiology). [1970]. Contract AT(11-1)-Gen-10. 16p. (CONF-710311–1). Dep. NTIS.

From second midwest interdisciplinary meeting, biophysics/radiation research; De Kalb, Ill. (19 Mar 1971).

Cultures of human HeLa and WI-38 cells, L cells of mice, and hamster cells were incubated in a medium containing FUdR and BUdR. Cultures were irradiated with 0, 250, 1000, and 10,000 R doses of x rays and the DNA was extracted. Results with L cells are presented in the form of graphs. The graphs show original density gradient profile of DNA from cells irradiated with 1000 R and incubated for 3 hrs in the presence of tritium-labeled BUdR; profiles of first rebands from normal density regions or original equilibrium density gradients; profiles of second rebands; and profiles of third rebands. It was found that the peaks of radioactivity were very close to the density of normal DNA. To quantify the results the specific activities of repaired DNA were determined. The results indicate that the chemical nature of single strand breaks requires that base insertion precede rejoining of these breaks. Rejoining of the great majority of breaks occurs in mammalian cells within the first hour after irradiation. The base insertion is manifested as repair replication. The extent of repair replication observed indicates that no more than three bases per break are inserted into DNA, demonstrating that repair of mammalian DNA does not involve extensive degradation and concomitant widening of the gap caused by the original damaging event. (H.L.W.)

37735 EFFECT OF X-IRRADIATION ON THYMIDINE KINASE ACTIVITY IN SYNCHRONOUS POPULATIONS OF HeLa CELLS. Gelbard, A. S.; Perez, A. G.; Kim, J. H.; Djordjevic, B. (Sloan-Kettering Inst. for Cancer Research, New York). Radiat. Res.; 46: No. 2, 334-42(May 1971).

The periodic synthesis of thymidine kinase during the cell cycle has been studied in synchronous populations of HeLa cells. There is a sharp decrease in enzyme activity after cell division followed by a rise in thymidine kinase levels which reaches a maximum several hours after the peak of DNA synthetic activity. Cells treated with inhibitors of protein or RNA synthesis early in the cycle have low levels of thymidine kinase activity. Cells exposed to irradiation, however, have a pattern of prolonged elevated levels of thymidine kinase activity. This altered pattern of enzyme activity resulting from x-irradiation can be mimicked by treatment of the cells with inhibitors of DNA synthesis or of cell division. The data indicate that radiation of a dose of 2000 rads does not interfere with the synthesis of the enzyme and that the prolonged elevation of thymidine kinase activity in x-irradiated cells reflects interference with the progression of the cell population to a phase of the cell cycle that is detrimental to the enzyme. (auth)

37736 MOLECULAR CAUSES OF BIOLOGICAL RADIATION DAMAGES. Fahr, E. (Univ., Wuerzburg, Ger.). Stud. Biophys.; 19: 1-20(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

On irradiation of biological systems the following subsequent processes were observed: absorption of irradiation; excitation of the absorbing molecule; photochemical reaction of the excited molecule; and biological effects (irradiation damages) originated by the photochemically modified molecule. The processes are discussed for nucleic acids since their photochemical transformations in many cases caused the irradiation damages observed in biological systems. (auth)

37737 PHOTOLYSIS OF THE PEPTIDE BOND. Mueller, H.-G. (Institut fuer Biophysik, Berlin). Stud. Biophys.; 19: 31-8(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

The alteration of the molecular weight distribution of the ribonuclease after uv irradiation (λ = 254 nm) proved the destruction of peptide bonds in proteins. In addition, the occurrence of carbonyl compounds in the enzymatic and acidic hydrolysates of the irradiated protein confirmed this result. This evidence disproves the propagated opinion that ultraviolet light does not break peptide bonds in a measurable yield. (auth)

37738 EFFECT OF THE U. V.-LIGHT ON THE SIDE CHAIN COTTON EFFECT OF THE RIBONUCLEASE A. Mueller, H.-G.; Koch, M. (Institut fuer Biophysik, Berlin). Stud. Biophys.; 19: 39-47(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

The optical rotation dispersion (ORD) and the circular dichroism (CD) demonstrated a side chain Cotton effect, which was lost by irradiation with ultraviolet light. This was an indication of denaturation processes. It was found that the Cotton effect is associated with the buried tyrosines of the ribonuclease. (auth)

Immunology

Refer also to abstract 37864.

37739 (RLO–2226-T-3-4) ULTRASTRUCTURE OF 19S ANTIBODY-PRODUCING CELLS FROM ALS, PHA, AND D_2O-TREATED ANIMALS. Neher, G. H.; Siegel, B. V. (Oregon Univ., Portland. Dept. of Pathology). [1970]. 13p. Dep. NTIS.

Plaque-forming cells from anti-lymphocyte serum, phytohemagglutinin, and deuterium oxide (D_2O) treated mice were examined with the electron microscope and compared to similar cells from untreated animals. The only differences between cells from control and immunologically depressed animals were an increase in the number of mitochondria per section of D_2O cells, and a lower average maturation of ALS and PHA plaque-forming cells than corresponding control cells. All the ultrastructural features noted in control cells were seen in cells from each experimental group. Abnormal plasma cells were present in all groups suggesting that this is a distinct cell type. (auth)

37740 (RLO-2226-T-3-5) STUDIES ON THE MEDIATION AND MECHANISM OF IMMUNOSUPPRESSION. Progress Report, September 1, 1970–August 31, 1971. Siegel, Benjamin V. (Oregon Univ., Portland, Medical School). Contract AT(45-1)-2226. 16p. Dep. NTIS.

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The immunologic hyperresponsiveness of NZB as compared to BALB/c mice was confirmed in studies that examined circulating hemagglutinin titers for mice of these two strains. Radiosensitivity studies showed a maximum resistance to irradiation at one month of age in NZB mice. Studies on autoimmune disease in NZB mice included effects of x radiation on life shortening, effects of x radiation on mice showing positive Coomb's test for hemolytic anemia, and radiation effects on production of antinuclear antibodies. The incidence of radiation thymomas in NZB mice exposed at different ages to various x-ray doses was compared to that of C57B1 mice. Electron microscope studies were conducted on delineation of the development and maturation of antibody-producing cells. Investigations were continued on depressed autoimmune responses in leukemia virus-infected NZB mice and on immunodepressive effects of oxygen. (H.L.W.)

37741 FUNCTION OF IRRADIATED BLOOD ELEMENTS. I. LIMITATIONS ON THE RESPONSE TO PHYTOHEMAGGLUTININ AS AN INDICATOR OF IMMUNOCOMPETENCE IN IRRADIATED LYMPHOCYTES. Coifman, Robert E.; Good, Robert A.; Meuwissen, Hilaire J. (Univ. of Minnesota, Minneapolis). Proc. Soc. Exp. Biol. Med.; 137: No. 1, 155-60(May 1971).

The ability of a lymphoid cell population to be stimulated to incorporate radio-labeled thymidine by phytohemagglutinin (PHA) has been widely accepted as a ready measure of cellular immune competence. Persisting PHA responsiveness in lymphocytes from irradiated blood, in particular, has been taken as evidence that radiation does not protect against the hazard of graft-versus-host reaction (GVH) in blood transfusion. Our independent conclusion that radiation of blood under appropriate conditions does protect immunologically incompetent recipients against GVH made necessary an effort to resolve this apparent contradiction. Irradiated cells stimulated with either PHA or allogeneic leukocytes have been studied in terms of known radiation sensitivity curves for cellular proliferation. These studies permit the conclusion that PHA responsiveness is not a valid measure of the immunocompetence of irradiated cells. Since the ability to replicate seems much more radiosensitive than the ability to respond, tests such as PHA responsiveness which measure only the ability to recognize and react to a mitogenic stimulus lose their validity in this context. (auth)

Ecology

Refer also to abstracts 37512, 37715, 37716, 37721, 37728, 37731, 37769–37773, 37777, 37785, 37789, 37791–37793, 37795, 37829, 37868, and 39183.

37742 (A/CONF.49/P-85) UNDERSTANDING THE DYNAMIC BEHAVIOR OF RADIONUCLIDES RELEASED TO THE ENVIRONMENT AND IMPLICATIONS. Auerbach, S. I.; Kaye, S. V.; Nelson, D. J.; Reichle, D. E.; Dunaway, P. B.; Booth, R. S. (Oak Ridge National Lab., Tenn.). Sep 1971. 18p. (CONF-710901-20). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The environmental behavior of radionuclides released to aquatic and terrestrial ecosystems from both routine plant operations and tracer experiments at Oak Ridge National Laboratory (ORNL) has been studied by ecologists during the past 15 years. Two important aspects of these continuing studies are: (1) radionuclides used as tracers in the environment help to delineate complex ecological processes and (2) radiolabels quantifying rate processes provide primary ecological information for developing dynamic models of radionuclide transfers to man. Systems analysis techniques are being used to simulate the environmental behavior of radionuclides. Chronic releases of small quantities of radionuclides to White Oak Lake and the Clinch River have provided a unique case study of the environmental behavior of several radionuclides. Radionuclides occurring regularly in organisms from White Oak Lake include ^{90}Sr, ^{137}Cs, ^{60}Co, and ^{3}H. Occasionally ^{106}Ru, ^{125}Sb, and ^{65}Zn are found. Because of dilution, only ^{90}Sr and ^{137}Cs are found regularly in the Clinch River. Coupling of field and laboratory data on selected radionuclides in fish, aquatic insects, mollusks, and crustaceans provides the necessary parameters for dynamic models of radionuclide movements in aquatic ecosystems. Research in terrestrial ecosystems has emphasized the biogeochemical cycling of fission products in forest, grassland, and old field ecosystems. Radionuclide dynamics (^{60}Co, ^{90}Sr, $^{95}Sr-^{95}Nb$, ^{106}Ru, ^{137}Cs, and ^{144}Ce) in natural plant communities have been followed where soil reaction products have formed. Plant translocations and food-chain studies with ^{22}Na, ^{42}K, ^{45}Ca, ^{85}Sr, ^{86}Rb, ^{131}I, and ^{137}Cs have detailed pathways and fluxes of additional radionuclides in these ecosystems. Research has provided insight into the budgets and turnover times of major nutrient elements and potentially hazardous radionuclides in contrasting ecological systems. Fifteen years of environmental research at ORNL strongly suggests that the dose necessary to evoke an unequivocally detectable biological response is considerably greater than that resulting from maximum permissible concentrations in the environment. (auth)

37743 (BMI-171-132) AMCHITKA BIOENVIRONMENTAL PROGRAM. AMCHITKA BIOLOGICAL INFORMATION SUMMARY. Fuller, R. Glen (Battelle Memorial Inst., Columbus, Ohio). May 1971. Contract AT(26-1)-171. 16p. Dep. NTIS.

Early in 1967, the United States Atomic Energy Commission, Nevada Operations Office (AEC/NVOO), began a detailed evaluation of Amchitka Island, in the western Aleutians, as a potential site for underground nuclear testing. In October 1969, a calibration underground test, Project Milrow, was carried out on Amchitka. Milrow involved the detonation of a nuclear device of about 1 megaton yield, approximately 4,000 feet below the island surface. The effects of Milrow were studied and documented by a variety of pre- and postshot observations. The bioenvironmental studies were designed to: (1) predict, document, and evaluate the effects of AEC testing activities on the biota and the environment; (2) recommend measures for minimizing adverse effects; and (3) predict and evaluate the dispersion of radionuclides in the marine environment and their potential transport to man via marine food chains, should there be an inadvertent release. Results are reported from studies of soils, vegetation, biota of freshwater streams and lakes, birds, and marine flora and fauna. (C.H.)

37744 (BMI-171-137) AMCHITKA BIOENVIRONMENTAL PROGRAM. RESEARCH PROGRAM ON MARINE ECOLOGY, AMCHITKA ISLAND, ALASKA. Annual Progress Report, July 1, 1969–June 30, 1970. Burgner, R. L.; Gilbertson, L. G.; Harbert, G. M.; (and others) (Washington Univ., Seattle. Fisheries Research Inst.). May 1971. Contract AT(26-1)-171. 102p. Dep. NTIS.

For Battelle Memorial Inst., Columbus, Ohio.

Research on the marine environment of Amchitka Island was continued along with evaluative studies of the effects of Milrow (October 2, 1969). The features studied included fish, invertebrates, algae, zooplankton, and physical oceanography. An occurrence of Pacific ocean perch in commercial quantities and of salmon in significant abundance was noted. Based on scale patterns, the sockeye salmon were thought to be of Bristol Bay origin. Pre- and postevent studies along with live-box experiments indicated no Milrow-related effects on the marine fish populations. Eight fish species not previously encountered were captured during the fiscal year, as well as additional species only tentatively identified from ichthyoplankton collected. The reproductive characteristics of near-shore fishes are summarized. Recoveries of tagged rock greenling indicated little movement of the fish from the point of inshore release and quite slow growth. Additional diet studies and the food web for some fishes are reported. Invertebrate studies revealed the occurrence of five species at Amchitka that are important commercially elsewhere. Live-box studies and postevent observations revealed no apparent effect of Milrow on marine invertebrates. Invertebrate zonation for 88 species is described for two littoral areas from fall studies. A list of the invertebrate species is appended. Marine algal studies in one littoral area have shown an apparent effect from Milrow resulting from movement of a fault in the intertidal zone. A die-off of algae on the uplifted side of this fault (IA-1) has been noted. It is possible that disturbances continue subtidally. Algal succession is expected to take 3 years and possibly longer. Additional algal studies indicated major differences between the present and previous transects studied and thus a need for observations of additional transects. A comparison of copepod abundance offshore in fall of 1967 and 1969 revealed differences in biomass and mean number per cubic meter. Copepod sampling in the vicinity of the Constantine Dock produced information on seasonal variation and the life histories of the major species. (auth)

37745 (BNWL-1550(Vol.1)(Pt.2)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1970 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME I. LIFE SCIENCES. PART 2. ECOLOGICAL SCIENCES. Vaughan, Burton E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1971. Contract AT(45-1)-1830. 108p. Dep. NTIS.

ALASKA—fallout monitoring during 1970

AVES—Branta canadensis moffitti, ecology of, Hanford Reservation, Washington, during 1950 through 1970

BETA PARTICLES—effects on development and survival of trout eggs in tritiated water

CESIUM-137—cycling in field plant–soil ecosystems following surface deposition

COLUMBIA RIVER—zinc-65 cycling in water–algae–fish food chains in
—ecology of, effects of heat effluents on animal and plant
ECOSYSTEMS—fires in desert-steppe, effects on animals and plants of
FALLOUT—monitoring in Alaska during 1970
FIRES—effects on animals and plants in desert-steppe ecosystems
FOOD CHAINS—cesium-137 content of lichen–caribou–man, in Alaska during 1970
—zinc-65 cycling in water–algae–fish, in Columbia River
HEATED EFFLUENTS—effects on ecology of animals and plants in Columbia River
MAN—radioisotope content of Eskimo, at Anuktuvuk Pass, Alaska, during 1970, cesium-137, iron-55, lead-210, polonium-210, strontium-89, and strontium-90
MICE—ecology of Pasco Basin, Washington
NITROGEN—cycling in plants and soil in desert-steppe ecosystems, effects of temperature on
OSTEICHTHYES—Salmo sp., effects of heat on growth of Columbia River
—disease incidence in Columbia River, during 1970, columnaris, gas bubble disease, and furunculosis
—Salmo gairdneri, radiation effects on development and survival of eggs of, in relation to tritium content of water
PLANTS—ecology of Pasco Basin, Washington
RICHLAND AREA (WASH.)—ecology of Canada geese during 1950 through 1970 at
SEED—radiation effects on germination of, from plants grown on soil treated with cesium-137 and strontium-90
STRONTIUM-90—cycling in field plant—soil ecosystems following surface deposition
WASHINGTON—climatology, ecology, geology, and hydrology of Pasco Basin in
WATER-t_2—effects on development and survival of trout eggs in
ZINC-65—cycling in water–algae–fish food chains in Columbia River (D.L.C.)

37746 (BNWL-1551(Pt,2), pp 1-4) INHALATION HAZARDS TO URANIUM MINERS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

The high incidence of lung cancer and other respiratory ailments in uranium miners requires the accurate characterization of the radionuclide, elemental, and organic content of the uranium mine air and their correlations to lung exposure. A combination detector-filter chamber was developed for the continuous measurement of radon decay products in samples of uranium mine air. Lung tissue samples from humans with no history of mining were analyzed by neutron activation to provide base line data for studies on uranium miners. (C.H.)

37747 (BNWL-SA-3873) MODELLING RADIONUCLIDES AND PESTICIDES IN FOOD CHAINS. Eberhardt, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1971]. Contract AT(45-1)-1830. 13p. (CONF-710501-7). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Some aspects of modelling the kinetics of trace substances, such as pesticides and radioisotopes, in food chains are discussed. The problems of sampling in space, time, and systems are considered in light of some case-histories and a food-chain simulation model. (auth)

37748 (BNWL-SA-3880) SIMILARITY RATIOS AND PATTERNS IN RETENTION OF TRACE SUBSTANCES. Thomas, J. M.; Eberhardt, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1969]. Contract AT(45-1)-1830. 20p. (CONF-710501-17). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

The concepts of allometry and similarity for the mathematical derivation of radioisotope retention in mammals as a sum of exponentials are reviewed. The possibility of using food chain models and biological equilibrium data for interspecies comparisons is discussed. It is suggested that the method may be extended to calculations of trace element, pesticides, and mercury cycling in ecosystems. (C.H.)

37749 (COO-1795-3) EFFECTS OF LIMNOLOGICAL FACTORS ON UPTAKE OF ^{137}Cs FALLOUT BY FISH. Final Report, June 1968–June 1971. Kevern, Niles R. (Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife). Contract AT(11-1)-1795. 6p. Dep. NTIS.

Data were obtained for specific conductance, ^{137}Cs, stable cesium, potassium, and sodium contents of water of six lakes. Specific activities of ^{137}Cs in largemouth bass (Micropterus salmoides) were calculated. Data are presented that identify and quantify the parameters that are most important in influencing uptake of ^{137}Cs by fish; these are concentrations in water of ^{137}Cs, potassium, and stable cesium, the latter two having negative correlations. An equation was developed for predicting uptake by fish when fallout or accidental inputs of ^{137}Cs to the water are given. A table is presented to show linear correlation coefficients between ^{137}Cs activities of bass and lake parameters. (H.L.W.)

37750 (COO-1795-6) EFFECTS OF BIOGEOCHEMICAL FACTORS ON THE ACCUMULATION OF ^{137}Cs FALLOUT BY LARGE-MOUTH BASS (MICROPTERUS SALMOIDES). Supplement to Final Report. Kevern, Niles R. (Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife). [1970]. Contract AT(11-1)-1795. 107p. Dep. NTIS.

Originally submitted as a thesis by Steven A. Spigarelli.

The factors that affect the accumulation of ^{137}Cs fallout by largemouth bass were studied in a group of southern Michigan lakes. The influences of sex, weight, and time of year were tested in Wintergreen Lake; the effects of limnological parameters were determined by comparing ^{137}Cs activities of bass collected from the six lakes during June, 1969. The following conclusions are supported by the data: a correlation between weight and Cs accumulation by bass was detected in the May, 1969 sample. The relationship was estimated to be curvilinear in that an increase in body burden with increased weight (positive slope) was characteristic of age two and three bass (200–900 gms) but the opposite (negative slope) was characteristic of bass weighing over 1100 gms. No significant relationship was demonstrated between the sex and ^{137}Cs activity of bass. The ^{137}Cs activities of age three bass decreased from May to September, 1969. A small increase in body burden was noted during October. The decrease in ^{137}Cs activity with time through September has not been adequately explained by diet changes. A definite pattern of concentration of ^{137}Cs between trophic levels was indicated. The most piscivorous species, yellow perch, contained the highest ^{137}Cs activities while the omnivorous bass were intermediate in activity and the insectivorous sunfish had the lowest body burdens. The levels of ^{137}Cs in all species of fish collected from Wintergreen Lake decreased between 1968 and 1969. Such a consistent decrease in the species analyzed indicates that the input of ^{137}Cs due to fallout is decreasing with time and that the previously deposited ^{137}Cs is accounting for an increasingly greater percentage of the total body burden of fish. The mean ^{137}Cs activities of age three bass collected from the six study lakes were significantly different and comprised a range of 0.10–1.11 pCi/gm wet weight. A general inverse relationship was observed between the alkalinity of the water and the accumulation of ^{137}Cs by bass. Simple correlation coefficients implied a strong inverse linear correlation between specific conductance of lake water and ^{137}Cs uptake by bass. However, the multiple regression analysis demonstrated that this apparent linear correlation was of secondary importance when all five independent variables were included in the analysis. The final prediction equation included [^{137}Cs], [Cs^+] and [K^+] of water and apparently accounted for about 99% of the variation between lakes. (auth)

37751 (COO-2122-5) CYCLING AND COMPARTMENTALIZING OF RADIONUCLIDES IN NORTHERN ALASKAN LICHEN COMMUNITIES. Hanson, W. C.; Eberhardt, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab. Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). [1971]. Contracts AT(45-1)-1830; AT(11-1)-2122. 22p. Dep. NTIS.

Cycling of cesium-137 and other fallout radionuclides in natural lichen communities of Northern Alaska was studied by periodic sampling on a year-round basis during the period 1964 to 1969. Maximum concentrations usually occurred during summer months and minima during winter months. Vertical strata of lichens, humus, and soil taken at those times showed pronounced seasonal shifting of radionuclides between community components. These data partially account for the sudden increase in cesium-137 body burdens of northern Alaskan caribou during spring months of each year and have important implications in the Eskimo populations dependent upon the caribou for basic food supplies. (auth)

37752 (COO-2122-8) SYNTHESIS AND ANALYSIS OF ALASKAN RADIATION ECOLOGY DATA. Technical Progress Report No. 1, September 1, 1970–May 31, 1971. Hanson, W. C.; Whicker, F. W. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). Contract AT(11-1)-2122. 11p. Dep. NTIS.

A mathematical model was developed for computer simulation of the ^{137}Cs cycle within the atmosphere-lichen-caribou-man food web at Anaktuvuk Pass. Data were obtained on ^{137}Cs concentrations in biota including man during 1964 to 1968. Quan-

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titative data concerning food intake estimates and biological half-times of ^{137}Cs in natural communities of people and lichens were obtained during 1965 to 1970. Cesium-137 concentrations in caribou flesh samples increased abruptly during spring migrations of animals from their winter range to the summer range. Analysis of stratified samples of lichens and their substrate showed a seasonal change in vertical distribution of ^{137}Cs and ^{90}Sr in terms of total amount of radionuclide distribution contained within the biomass. It was concluded that radionuclide cycling within arctic lichen communities is a more dynamic mechanism than previously noted, that it is compatible with several studies of northern lichen communities, and that it partially accounts for the spring pulse of ^{137}Cs body burdens of northern Alaskan caribou observed annually. (H.L.W.)

37753 (NYO–3995-18) EFFECTS OF ENVIRONMENTAL STRESS ON THE COMMUNITY STRUCTURE, PRODUCTIVITY, ENERGY FLOW, AND MINERAL CYCLING IN SALT MARSH EPIPHYTIC COMMUNITIES. Lee, John J.; Tietjen, John H.; Stone, Robert J.; (and others) (City Coll., New York. Dept. of Biology). [1970]. Contract AT(30-1)-3995. 31p. (CONF-710501–9). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Sublittoral salt marsh epiphytic communities are being studied and modeled to gain insight into the changes in productivity and community structure which do, or could, result from radionuclide, thermal, organic, pesticide or herbicide pollution. Foraminifera, important as both ecological indicators and in marine biogeochemical cycling, and other prominent members of the community have been isolated in culture and their physiological ecology, energy budgets, mineral cycling, and life cycles studied. The carbon budget of the community has been studied from both an overall view and in terms of individual species. The Enteromorpha community is very productive. At the peak of primary productivity during the summer Enteromorpha can fix ~10% of its dry weight/hr. Herbivores in the community consume most of the carbon fixed. Nutritional studies of epiphytic algae suggest that the carbon budget of the community is augmented by heterotrophy. Algae can compete successfully with bacteria for labeled substrates. In juvenile Rhabditis marina, a marine nematode, the biological half-life of ^{14}C is ~2 days. The effect of competition among pairs and small groups of herbivores is variously reflected as phase and amplitude changes in the growth rate. Radionuclides are excellent tools for measuring competition, feeding, growth, and mineral cycling rates of foraminifera and nematodes. The removal rates of ^{45}Ca and $^{89,90}Sr$ from coastal marine environments have been estimated. Ca and Sr are tightly bound to foraminiferan shells and in alkaline pH and low hydrostatic pressure do not exchange with the environment. Foraminifera and nematodes have complex positions in the marine food web. Some marine bacteria have metabolites, otherwise unavailable, required by the herbivores under study. (auth)

37754 (NYO–3995-20) THE EFFECTS OF ENVIRONMENTAL STRESS ON THE COMMUNITY STRUCTURE AND PRODUCTIVITY OF SALT MARSH EPIPHYTIC COMMUNITIES. Progress Report, January 31, 1970–April 30, 1971. Lee, John J. (City Coll., New York. [Dept. of Biology]). Contract AT(30-1)-3995. 184p. Dep. NTIS.

Species diversity, succession, competition, food web complexion and the mineral cycling in marine salt marsh epiphytic communities are being studied. The breakthrough in media design should open the way for culture and laboratory study of many hitherto unisolated salt marsh microorganisms, micrometazoa and larvae and lead to the understanding of many aspects of community regulation. The rates and conditions necessary for removal of ^{45}Ca and $^{89-90}Sr$ from the coastal marine environment by foraminifera were calculated. Tracer techniques were used in quantitative studies of C and P turnover rates in marine nematodes and foraminifera. The biological half life of C and P in Rhabditis marina is ~2 days. Some aspects of the intraspecific and interspecific competition among herbivores were studied in tournament tracer feeding experiments. In other tournament experiments, the effect of competition among pairs and small groups of herbivores was shown to be reflected as phase and amplitude changes in growth pattern. The life cycles and physiological ecology of several epiphytic organisms are reported. Primary productivity and respiration of Enteromorpha, its epiphytes and the mixed community were measured. At the peak of primary production during the summer at optimum light and temperature Enteromorpha fixes carbon at a rate 10% of its dry weight/hour. Most of the carbon fixed is consumed by the epiphytic community. (auth)

37755 (ORO–2066-15) EFFECTS OF GAMMA RADIATION ON TREE SEED AND SEEDLINGS. Progress Report. Heaslip, Margaret B. (Morehead State Univ., Ky.). [1968]. 29p. Dep. NTIS.

Studies were continued on pine seedlings as a biological check on the effectiveness of nuclear waste disposal at Maxey Flats, Kentucky. Seedlings of Pinus echinata, P. strobus, and P. virginiana were planted over nuclear waste disposal pits north of Morehead State University as a check on burial methods being employed. Dosimeters used to monitor the exposure dose of seedlings are described. Radiation damage consisted of reduction of internode elongation of stems and premature shedding of needles on scattered seedlings. Pinus virginiana had the greatest survival value and the fastest growth rate of the three species. Correlations of the beta and alpha activities of the three species with rate of growth and age of burial pit were made and results are tabulated. Studies on effects of γ radiation of tree seeds on the radiosensitivity of the X_2 generation were continued. Earlier studies on seeds of buckeye, red bud, white ash, black walnut, sweet gum, sycamore, white oak, and black oak are reviewed. Following exposure of ash seeds to 0, 10, 20, 25, and 30 kR γ rays, survival dropped abruptly at 25 kR. Germination and survival of X_2 generation ash seed exposed to γ rays did not differ significantly from control seed. Long term studies were continued on trees gamma irradiated as seed or seedlings and planted in a secondary forest. It was found that ash was the most γ resistant and white oak the most sensitive of the three species studied. Survival and stem elongation decreased as the level of irradiation increased. Ash and white oak were both most radiosensitive when physiologically active. (H.L.W.)

37756 (RLO–2225-T-1-4) EFFECTS OF THERMAL SHOCK AND IONIZING RADIATION ON PRIMARY PRODUCTIVITY. Grayum, Michael M. (Washington Univ., Seattle. Lab. of Radiation Ecology). 10 May 1971. Contract AT(45-1)-2225-T-1. 17p. (CONF-710501–8). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

The effects of thermal shock, ionizing radiation, and thermal shock plus ionizing radiation were studied by measuring the utilization of carbon in the photosynthetic process. The experiments were designed to increase the water temperatures from 5 to 35 C above the ambient temperature in a period of 10 to 20 seconds, simulating temperature changes to be expected in the secondary coolant of a nuclear reactor. The productivity of pure cultures of Chlamydomonas reinhardi and Monochrysis lutheri and of mixed phytoplankton species from Lake Washington and Puget Sound water samples was determined by use of the ^{14}C technique and liquid scintillation counting methods. The specific ambient temperatures and the temperatures at which a decrease in productivity was observed are as follows: Chlamydomonas, 25 and 45 C; Monochrysis, 20 and 36 C; Lake Washington phytoplankton, 21 and 37 C; and Puget Sound phytoplankton, 12 and 25 C. There was no recovery in primary productivity from thermal shock after the lots were returned to ambient temperature. In most cases, productivity was stimulated by small temperature increases. A significant decrease in carbon utilization occurred at all doses of gamma radiation in the range from 50 to 400 krads. A significant interaction effect was found between thermal shock and gamma radiation on carbon utilization by Chlamydomonas. (auth)

37757 (UCLA–12-817) REVEGETATION PROBLEMS FOLLOWING NUCLEAR TESTING ACTIVITIES AT THE NEVADA TEST SITE. Romney, E. M.; Wallace, A.; Childress, J. D. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [nd]. Contract AT(04-1)-Gen-12. 21p. (CONF-710501–3). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Wherever vegetation was destroyed at the Nevada Test Site as the result of nuclear testing activities, the Salsola species and native annual species and grasses have grown abundantly in subsequent years on those areas. Experience indicates, however, that decades of time are necessary for the perennial shrub vegetation on a disturbed site to return to its original state. In disturbed areas on Pahute Mesa, the germination and survival of native shrub seedlings have been abundant in recent years and sufficient to return that portion of the southern Great Basin Desert to its original condition. After severe drought periods many new seedlings have disappeared, not directly because of drought but because of browsing animal activity. In the Mojave Desert portion of the Nevada Test Site, the germination and survival of shrub seedlings have been much slower on disturbed sites than at Pahute Mesa. Animals have destroyed virtually all shrubs which we have transplanted into disturbed areas. Nevertheless, transplanting has been successful when protected from browsing animals, and this appears to be a practical means of shortening the vegetational recovery time for these disturbed areas. (auth)

37758 PREDICTION MODELS FOR ^{90}Sr AND ^{137}Cs LEVELS IN THE HUMAN FOOD CHAIN. Aarkrog, A. (Danish Atomic Energy Commission Research Establishment, Risoe). Health Phys.; 20: 297-311(Mar 1971).

Milk, rye, barley, wheat, oats, potatoes, cabbage, carrots, beef, pork, and total diet were collected all over Denmark since the 1961 to 62 test series and analyzed for ^{90}Sr and ^{137}Cs. Along with the performance of diet measurements, precipitation, soil, and air samples were collected and analyzed for ^{90}Sr. The diet levels were related to the fallout data by a least squares analysis. It was not essential whether concentrations in air (or precipitation) or deposited activity were used in the rate and lag terms, although the deposition data tended to give the best models. Strontium-90 determinations in human bone and whole-body ^{137}Cs measurements were performed for the same period as the diet measurements. Quantitative models of the transfer of ^{90}Sr and ^{137}Cs to man were calculated in analogy with the equations used for diet. The $OR_{bone/diet}$ was calculated from the soil factors in the equations. The prediction models were transformed to exponential equations, which served for the calculation of the dose commitments to the Danish population. (auth) (UK)

Genetics and Cytogenetics

Refer also to abstracts 37856, 37857, 37863, 37896, 37901, 37903, 37907, and 37908.

37759 (A/CONF.49/P-677) GENETIC EFFECTS OF RADIATION. Russell, W. L. (Oak Ridge National Lab., Tenn.). Sep 1971. 17p. (CONF-710901-53). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Attempts to detect radiation-induced genetic damage in man have, so far, proved inconclusive. Consequently quantitative estimates of genetic hazard are still based on results from other organisms, primarily the mouse. Even though the point estimates of genetic effects in man have shown no significant increase over controls, the upper confidence limits of these provide at least some basis for comparison with the mouse results. In the experimental work on the mouse, emphasis has been placed on the effects of basic physical and biological factors that affect γ- and x-radioinduced mutagenesis. These include the effects of radiation dose, dose rate, dose fractionation, radiation quality, age at exposure, and the interval between irradiation and conception. The differences in response of the two sexes, of the different germ-cell stages, and of various gene loci have also been investigated, along with dependent variation in the relative frequencies of viable mutations, lethals, small deficiencies, and major chromosomal aberrations. The importance of some of these factors and the interactions between them reveal a much greater complexity in the mutation process than was originally imagined. For example, the discovery, first reported in 1958, that radiation delivered at low dose rates produces fewer mutations in mice than does the same total dose delivered at a high dose rate suggested the existence of a repair mechanism previously unsuspected. Subsequent exploration of a wide range of dose rates provided further evidence of repair and showed marked differences in response of the two sexes and various germ-cell stages. Current estimates of human hazards based on these results with specific-locus mutations in the mouse suggest that, at low levels of irradiation, the risk from this type of genetic damage may be considerably less than was estimated from the data available when the present permissible levels of radiation were chosen. (auth)

37760 (ANL-7770, pp 116-18) MAMMALIAN GENETICS. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

Studies were continued on determination of the radioinduced mutation rate for sex-linked lethals and detrimentals in the mouse. A three-generation test system designed to detect lethal and detrimental mutations on the X chromosome of the mouse gave an estimate of the radioinduced rate as 8.5×10^{-5}/R/X with 95% confidence limits of 2 and 15×10^{-5}. Associated evidence of reduced litter size confirms the occurrence of genetic damage in the form of lethals and detrimentals, but it has not been possible to identify or isolate a categorical lethal. Data are presented on the genetic identification and location of a controller gene, Cg, on the normal X chromosome of the mouse. The gene is identified by its enhancing action on the phenotypic expression of linked mutant genes. (H.L.W.)

37761 (CONF-701125-1) MUTATION BREEDING IN SOYBEANS. Koo, F. K. S. (Puerto Rico Nuclear Center, Rio Piedras). [1970]. Contract AT(40-1)-1833. 8p. Dep. NTIS.

From Meeting on induced mutations and crop improvement; Buenos Aires, Argentina (16 Nov 1970).

Reviewed in this paper are the accomplishments of the past 20 years and the new investigations in progress on the subject of soybean mutation breeding in the world. Topics scrutinized include yield, maturity, disease resistance, quantity and quality of oil and protein, heat tolerance, photorespiratory deficiency, and radioinduced mutations. As evident in some of the studies presented here, this additional breeding tool has enabled the breeders to attack the problems of importance in soybean improvement. (auth)

37762 (NP-18712) REPORT OF THE BOSE INSTITUTE FOR 1968-69. (Bose Inst., Calcutta (India)). 174p. Dep. NTIS (U. S. Sales Only).

Separate abstracts were prepared on three sections of the report. (C.H.)

For abstracts of individual sections see: 37763, 37764, and 38925.

37763 (NP-18712, pp 59-104) BOTANY. (Bose Inst., Calcutta (India)).

In Report of the Bose Institute for 1968-69.

Mutants of spinach (Spinacea sp.,), garden peas (Lathyrus sativus), and fennel (Trigonella foenum-graceum) induced by exposure of seeds to various doses of x radiation were examined for changes induced in the rate of seed germination, growth rate, crop yield, morphology, and plant survival. The effects of exposure of pollen of fennel and spinach to various doses of x radiation on pollen morphology were also examined. Results are included from studies of the anatomy, cytology, and physiology of a number of plant species. (C.H.)

37764 (NP-18712, pp 105-49) MICROBIOLOGY. (Bose Inst., Calcutta (India)).

In Report of the Bose Institute for 1968-69.

Mutants of Aspergillus chevalieri yielding antibiotic were induced by exposure of spores to doses of 10, 20, 30, and 40 Kr γ radiation, with increased antibiotic potency in mutants induced by the lower doses. Mutants of Aspergillus wentii were induced following exposure of spores to doses of 10, 15, 25, and 30 Kr γ radiation, with the maximum mutagenic effect observed at 25 Kr. Mutants of Streptomyces indicans induced by exposure of spores to uv radiation at 100 ergs/mm^2 sec. for 20, 40, 60, and 80 sec. were studied for reversal of mutation. The percent of reversal increased with radiation dose. Mutants induced by uv irradiation in Penicillium vermiculatum and Chaetomium areum were studied for morphological, nutritional, and physiological characteristics. A new antibiotic, boseimycin, was isolated from Streptomyces boseii sp. novo that is effective against gram positive and gram negative bacteria, fungi, and yeast. Results are reported from studies on the antibiotic and fungistatic properties of a number of fungi. (C.H.)

37765 (NYO-3893-20) ULTRAVIOLET LIGHT EFFECTS ON NUCLEIC ACID FORMATION AND GENETIC EVENTS IN BACTERIA. Annual Progress Report. Doudney, C. O. (Albert Einstein Medical Center, Philadelphia, Pa. Dept. of Genetics). Apr 1971. Contract AT(30-1)-3893. 17p. Dep. NTIS.

Basic mechanisms involved in the phenomenon of uv-induced mutation in Escherichia coli and their relationship to DNA restoration mechanisms after uv-damage were investigated. Studies of ultraviolet effects on DNA replication and the restoration mechanisms involved in recovery of the bacterial cell's capacity to make DNA were continued. (auth)

37766 CHROMOSOME DAMAGE IN PATIENTS WHO HAVE HAD INTRA-ARTICULAR INJECTIONS OF RADIOACTIVE GOLD. Stevenson, Alan C. (Medical Research Council Population Genetics Unit, Oxford); Bedford, Jean; Hill, Alan G. S.; Hill, Hilary. Lancet; 1: 837-9(24 Apr 1971).

An investigation was made of chromosome abnormalities in peripheral lymphocytes of twelve patients who had had ^{198}Au injections only and two who had had radioactive gold and external irradiation (x and gamma rays). The frequency of damaged cells in patients without external irradiation was 8.5% (mostly dicentrics), compared with 0.48% for controls. It is suggested that ^{198}Au injections should be limited, particularly in younger patients, to cases where the procedure is expected to give much better results than other methods. (auth) (UK)

37767 UV MUTAGENESIS. Bridges, B. A.; Munson, R. J. (Medical Research Council, Harwell, Eng.). Stud. Biophys.; 19: 49-57(1970).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

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The physiology of uv-induced mutations in Escherichia coli is discussed. Possible steps between initial damage and final mutation in molecular terms were analyzed. UV mutagenesis is essentially an activity of the cell rather than of uv directly. The roles of pyrimidine dimers and of gaps in the DNA strand are emphasized. (H.B.G.)

37768 INVESTIGATIONS ON REPAIR DEFECT MUTANTS OF PROTEUS MIRABILIS. Boehme, H. (Zentralinstitut fuer Genetik und Kulturpflanzenforschung, Berlin). Stud. Biophys.; 19: 159-62(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

Mutants of Proteus mirabilis, which possess a reduced repair capability, are described. These mutants exhibit diminished sensitivity to uv radiation and enhanced mutation rate. $MnCl_2$ pretreatment increased susceptibility to subsequent x irradiation as well as to photodynamic treatment. The effects of $MnCl_2$ pretreatment can also be demonstrated on uv inactivation in the repair process of normal wild types of Proteus mirabilis. $MnCl_2$ pretreatment combined with caffeine posttreatment was additive with respect to uv inactivation. (H.B.G.)

Health Physics and Safety

Refer also to abstracts 37508 and 37697.

Radioactive Contamination and Decontamination

Refer also to abstracts 37562, 37727, 37728, 37744, 37745, and 37748–37750.

37769 (BNWL–1551(Pt.2)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1970 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME II. PHYSICAL SCIENCES. PART 2. RADIOLOGICAL SCIENCES. Nielsen, J. M.; (and others) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1971. Contract AT(45-1)-1830. 97p. Dep. NTIS.

Separate abstracts were prepared for 15 sections of this report. (C.H.)

For abstracts of individual sections see: 37259, 37307, 37420, 37498–37500, 37503, 37504, 37712, 37713, 37746, 37770, 37771, 38523, and 38524.

37770 (BNWL–1551(Pt.2), pp 5-11) RATES OF DEPOSITION OF AIRBORNE RADIONUCLIDES IN THE ALASKAN ENVIRONMENT. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

The 1968 to 1971 atmospheric deposition rates, routes, biological uptake rates, and concentrations of 18 fallout radionuclides, and their stable element counterparts were investigated in the terrestrial and marine environments in Alaska. Emphasis was placed on the food chains that consistently lead to high radionuclide concentrations. The ratio of ^{108m}Ag in seawater to that in marine organisms indicated a concentration factor of 10^4 to 10^6, and terrestrial herbivores (caribou, deer, and elk) concentrated ^{108m}Ag in the liver. Concentration of ^{137}Cs, ^{65}Zn, and ^{55}Fe was observed in salmon. Salmon-eating Eskimos had 20- to 100-fold higher content of ^{55}Fe than caribou-eating Eskimos or residents of Richland, Wash. (C.H.)

37771 (BNWL–1551(Pt.2), pp 46-50) ^{55}Fe AND LEAD IN THE HUMAN POPULATION OF THE WORLD. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

The transfer of ^{55}Fe from fallout, with special emphasis on the concentrations in man and in food chains leading to human consumption, was investigated. Transfer is being measured in the general population as a function of age, sex, and diet, including the dilution effect of stable iron. The same samples are used to measure the transport of Pb, ^{210}Pb, and ^{210}Po in the biosphere. (auth)

37772 (BNWL-SA–3863) CYCLING AND COMPARTMENTALIZING OF RADIONUCLIDES IN NORTHERN ALASKAN LICHEN COMMUNITIES. Hanson, W. C.; Eberhardt, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1971]. Contract AT(11-1)-2122. 16p. (CONF-710501–1). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Cycling of ^{137}Cs and other fallout radionuclides in natural lichen communities of Northern Alaska was studied by periodic sampling on a year-round basis during the period 1964 through 1969. Maximum concentrations usually occurred during summer months and minima during winter months. Vertical strata of lichens, humus and soil taken at those times showed pronounced seasonal shifting of radionuclides between community components. These data partially account for the sudden increase in ^{137}Cs body burdens of northern Alaskan caribou during spring months of each year and have important implications in the Eskimo populations dependent upon the caribou for basic food. (auth)

37773 (BNWL-SA–3878) FALLOUT RADIOCESIUM IN SEDGES AND TROUT OF A CASCADE MOUNTAIN BOG. Rickard, W. H.; Eberhardt, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1971]. Contract AT(45-1)-1830. 20p. (CONF-710501–12). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Radiocesium from worldwide fallout was measured in the sedges and in the eviscerated bodies of cutthroat trout collected from a Cascade Mountain (Wash.) bog during the years 1967, 1968, 1969, and 1970. The bog is poor in essential mineral nutrients and located in a high rainfall area. These environmental features enhance the incorporation of radiocesium into the mineral cycling of bog biota. The early spring harvests of sedges generally had the highest concentration of radiocesium and the autumn harvest the smallest amounts. Radiocesium values in sedge ranged between 5 and 30 picocuries per gram dry weight. The peak harvest yield of sedge mat vegetation amounted to 210 g/m^2 in 1968 and 1969. The ^{137}Cs concentration of eviscerated trout ranged from less than 1 picocurie per gram dry weight to 5 picocuries. In general the larger sized fish had higher burdens of ^{137}Cs than smaller sized fish. (auth)

37774 (CEA-N–1428) ^{90}Sr LEVELS IN HUMAN BONES COLLECTED IN 1969. Jeanmaire, Lucien; Patti, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1971. 15p. (In French). Dep. NTIS (U. S. Sales Only).

The levels of ^{90}Sr in human bones collected in the Paris area in 1969 are given. The results for the different age categories are presented in a table. The main trend observed is a slight decrease in contamination for almost all the age groups above one year. (France)

37775 (CLOR–71/D) CONTENT OF ^{137}Cs AND POTASSIUM IN DIET OF SOME POPULATION GROUPS AND IN SOME FOODSTUFFS IN POLAND IN 1965–1966. Pietrzak-Flis, Zofia (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1968. 18p. Dep. NTIS (U. S. Sales Only).

Contents of ^{137}Cs and K were determined for the period of 1965 to 1966 in diets of 4 to 6 year-old children from Warsaw and 16 to 18 teenagers from Sochaczew, and contents of these elements were also determined in milk, meat, flour, potatoes and vegetables collected in Warsaw and at Sochaczew. The daily intakes of ^{137}Cs in diets were similar for both age groups, and in 1966 they were about 20% lower than those in 1965. On the basis of the determined daily intakes the body burdens were calculated for the two age groups. In 1965 in central Poland the major contribution to the ^{137}Cs content in diet was from meat 41.6%, lower amounts being absorbed from milk 29.6%, grain products 18.0%, and potatoes 9.6%. Content of ^{137}Cs in milk and flour collected from Warsaw remained practically constant in 1965 and 1966, whereas that in meat and potatoes was in 1966 1.8 and 1.4 times less than in 1965, respectively. (auth)

37776 (CONF-690527) [RADIOACTIVITY IN SCANDINAVIA]. Fifth R.I.S. Symposium, Helsinki, May 19–20, 1969. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 68p.

Separate abstracts were prepared on four papers presented at this symposium. Abstracts of 22 additional papers presented orally are included. (C.H.)

For abstracts of individual papers see: 37715, 37716, 37777, and 37778.

37777 (CONF-690527–, Paper 1) EVOLUTION OF STRONTIUM AND CESIUM CONTAMINATION IN GRASS AND MILK IN RELATION TO THE MOMENT OF DEPOSITION OF THE RADIONUCLIDES ON PASTURE. Kirchmann, R.; van den Hoek, J.; Colard, J. 7p.

From fifth R.I.S. symposium; Helsinki, Finland (19 May 1969). In Radioactivity in Scandinavia.

Seasonal factors affecting the transport of ^{134}Cs and ^{85}Sr through pasture grass-milk-man food chains were investigated. It was concluded that direct foliar retention was the mechanism responsible for the uptake of ^{134}Cs and ^{85}Sr by cattle and highest values were observed during spring and early summer months. (C.H.)

37778 (CONF-690527–, Paper 3) ^{90}Sr in HUMAN BONE IN FINLAND IN 1967–1968. Salo, Kalervo; Uotila, Unto. 3p.

From fifth R.I.S. symposium; Helsinki, Finland (19 May 1969).

In Radioactivity in Scandinavia.

Data are presented on the content of ^{90}Sr in samples of human bones collected in Finland during 1967 and 1968. A relation between the content of ^{90}Sr in bones and milk consumption was reflected by the ^{90}Sr content in bones from the youngest age group. (C.H.)

37779 (EUR–4508) STUDIES ON THE RADIOACTIVE CONTAMINATION OF THE SEA. Annual Report, 1968–69. Bernhard, M. (Comitato Nazionale per l'Energia Nucleare, La Spezia (Italy). Laboratorio per lo Studio della Contaminazione Radioattiva del Mare). 1971. 110p. (RT/BIO–(70)11). Dep. NTIS (U. S. Sales Only). EUR F.Fr. 16.60.

The program laid down calls for studies of the factors that influence the uptake, accumulation, and loss of radioisotopes by different inorganic and organic constituents of the marine environment. The program is divided into two parts: a survey of environmental elements and factors in a sampling area, and experiments on the influence of environmental factors on the uptake, accumulation, and loss of radioisotopes by different inorganic and organic constituents of the marine environment in relation to the data obtained in the survey. The task of carrying out this program has been divided between seven groups: chemistry, botany, zooplankton, fisheries biology, microbiology, geology, biochemistry, and special developments. An account is given of the results obtained by these groups in 1968. (auth)

37780 (EUR–4612, pp 223–48) PRESENT POSITION AND PROBLEMS OF CHELATION THERAPY. Volf, V. (Kernforschungszentrum, Karlsruhe (West Germany)).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

The high therapeutic effectiveness of various chelating agents after incorporation of transuranium elements has been demonstrated many times. Practical needs, however, require that the effectiveness of chelating agents should also be investigated under less favorable conditions, for example, when therapy is commenced at a later stage and/or when the metal is in colloidal or insoluble form. In order to obtain a therapeutic effect under these conditions, it is necessary to apply stronger chelate doses over a longer period, and the toxic side effects of the chelating agents may be the limiting factor. (auth)

37781 (EUR–4612, pp 273–87) STUDY OF A CASE WHICH INVOLVED A WOUND CONTAMINATED WITH PLUTONIUM AND ^{241}Am. Hesp, R.; Ledgerwood, R. M. (United Kingdom Atomic Energy Authority, Sellafield (England). [Production Group]).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Results are presented of studies on a case in which a man received a finger wound contaminated with ^{241}Am and ^{239}Pu. The wound was treated immediately by surgical excision, and DTPA was administered during the following three days. The retention of plutonium and americium-241 in the wound was measured over a period of about 700 days. Depth estimations indicated that the contamination was about 1.0 cm below the skin, probably close to the surface of the bone. Attempts were made to detect contamination translocated to other parts of the body. (auth)

37782 (EUR–4612, pp 563–72) SURGICAL TREATMENT OF ALPHA-CONTAMINATED INJURIES. Ohlenschlaeger, L. (Kernforschungszentrum, Karlsruhe (West Germany)). (In German).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Experience in the treatment of alpha-contaminated injuries is reported for a total of 148 contaminated injuries given surgical treatment. In order to apply the treatment rapidly and effectively, a decontamination-surgery room with the appropriate monitoring equipment was installed. Organized medical care for the 800 people working with alpha-activity was devised for this purpose. The program included: first aid at the accident spot administered by trained lay helpers; medical treatment in the medical decontamination center; and initial intervention for grave injuries in the event of a disaster. In order to apply this three-stage plan in practice, the personnel concerned had to be familiar with the problems of first aid, at the accident spot. In this way it became possible to apply first aid measures quickly and efficiently in instances of contaminated injuries. The time lapse between the occurrence of the accident and first medical care can be kept within reasonable limits if the three-stage plan is adhered to. (auth)

37783 (EUR–4612, pp 573–83) WOUND CONTAMINATION EXPERIENCE; FIRST AID ON WORKING PREMISES. Kiy, M. R.; Schneider, V. W. (Alpha-Chemie und Metallurgie G. m. b. H., Leopoldshafen (West Germany)). (In German).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Since the plutonium plant was put into operation five years ago, about 10 injuries with suspected wound contamination have occurred at ALKEM. All injured persons were treated by the Medical Section of the Gesellschaft für Kernforschung. A small amount of plutonium was detected in the blood of only one of the victims. The causes of these injuries and the measures taken to avoid a repetition are explained. A description is given of the procedure followed in cases of injury with suspected wound contamination. (auth)

37784 (EUR–4612, pp 595–629) CONTAMINATION INCIDENT AT THE BR2 COMPLEX BY ^{241}Am AND ^{242}Cm. DECONTAMINATION OF THE INSTALLATIONS. Pele, J. P.; Van de Voorde, N.; Vanhaelewijn, R. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). (In French).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

In May 1967, the deterioration of a capsule initially containing 7 times 1.5 g of Am-241 during irradiation in the BR2 reactor caused extensive contamination of the BR2 complex, and a shut down of the reactor for two months. The capsule had ruptured about one month before the contamination was detected. A detailed investigation was carried out to determine the locations and levels of contamination in the buildings and reactor circuits (surfaces, water, control rods, experimental facilities); the personnel were also subjected to a systematic examination. Alpha contamination in the water of the primary circuit was of the order of 300 to 4000 dps/ml and the activity on the surfaces of this circuit was around 10^6 dps/dm2. Procedures to decontaminate the various circuits, objects, and surface are described. The activity was attributed to mixed ^{242}Cm and ^{241}Am. (auth)

37785 (FOA–4–4484) STUDIES ON THE TRANSPORT OF FISSION PRODUCTS THROUGH FOOD CHAINS. I. ^{137}Cs IN VEGETATION AND MILK AT THE EXPERIMENTAL FARMS OF THE SWEDISH AGRICULTURAL COLLEGE IN 1963. Fredriksson, L.; Ariksson, A. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jul 1966. 38p. Dep. NTIS (U. S. Sales Only).

During the vegetation period in 1963 the content of ^{137}Cs and K was determined in the main crops grown for cattlefeed on seven different experimental farms belonging to the Swedish Agricultural College. At the same time the content of ^{137}Cs in the milk produced at the farms was ascertained. The results of these measurements are reported and discussed with special reference to the prevailing fallout situation. (auth)

37786 (LA–4661) BETA RADIOACTIVITY IN ENVIRONMENTAL AIR AND PRECIPITATION AT LOS ALAMOS, NEW MEXICO, FOR 1970. Kennedy, William R.; Aeby, Jack (Los Alamos Scientific Lab., N. Mex.). May 1971. Contract W-7405-eng-36. 9p. Dep. NTIS.

Beta activity of particulate matter of both air and precipitation for 1970 is reported for Los Alamos, New Mexico. The lower monthly average levels found in precipitation collections and the slightly higher levels found in the air samples indicate that 1970 was a drier year than 1969 with 14.93 and 25.67 in. of precipitation, respectively. (auth)

37787 (NP–18731) ^{90}Sr FALLOUT DEPOSITION AND SURFACE AIR GAMMA ACTIVITY IN U.A.R. DURING 1969 AND ^{90}Sr IN HUMAN BONES DURING 1968 AND 1969. Mahmoud, K. A.; Moloukhia, M. K.; Abdel-Latif, S. A.; Ahmed, M. W. (Atomic Energy Establishment, Cairo (Egypt). Environmental Labs.). Jul 1970. 7p. Dep. NTIS (U. S. Sales Only).

Samples of dry fallout and precipitation were collected at five stations during 1969 and analyzed for strontium-90. The tabulated results reveal no significant changes between 1968 and 1969. Data on gamma activity in surface air were collected from aerosol stations at Cairo, Alexandria, and Port Said. Gamma activities are expressed in units of photons per minute per one thousand standard cubic meters. Analysis of human bones for strontium-90 was carried out on two age groups, 5 to 19 years, and 19 to 55 years, using vertebrae and femurs. (H.L.W.)

37788 (NP–18844) TRITIUM CONTENT MEASUREMENTS ON A VARIETY OF WATER SAMPLES. THIRD LISTING. Tech-

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nical Memorandum 25/1970. Hughes, M. W. (Commonwealth Scientific and Industrial Research Organization, Adelaide (Australia). Div. of Soils). 7 Jun 1970. 8p. Dep. NTIS (U. S. Sales Only).

Rainfall samples collected at sites in South Australia, Victoria and New South Wales, and South Australian bore water were analyzed for tritium. Tabulations continue results reported as NSA 25: 13103 and 25: 13120 and cover the first half of 1970. (Australia)

37789 (NYO-3446-15) RADIOACTIVE FOODCHAINS IN THE SUBARCTIC ENVIRONMENT. Technical Progress Report, August 15, 1970–August 14, 1971. Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). May 1971. Contract AT(30-1)-3446. 120p. (In English and Swedish). Dep. NTIS.

CESIUM-137—content of diet and man in Finland during 1961 through 1971
—metabolism in man, biological half-life for
DEER—cesium-137 content of caribou and reindeer, in Finland during 1966 through 1971
DIET—radioisotope content of, of Lapps in Finland during 1961 through 1971
ECOSYSTEMS—radioisotope content of aqueous and terrestrial, in Finland
FALLOUT—monitoring in Finland during 1961 through 1971
FOOD CHAINS—radioisotope transport through lichen–reindeer or caribou–man
IRON-55—content of diet and man in Finland during 1962 through 1971
LEAD-210—content of aqueous and terrestrial ecosystems in Finland
MAN—radioisotope content of Lapp, in Finland during 1961 through 1971
MEATS—reindeer, radioisotope content in Finland during 1966 through 1971
PLANTS—radioisotope content in Finland during 1970, antimony-125, cesium-137, manganese-54, ruthenium-106, and zirconium-95
POLONIUM-210—content of aqueous and terrestrial ecosystems in Finland
POTASSIUM-40—content of man, measured by whole-body counting
SODIUM-24—metabolism in man, biological half-life for
(D.L.C.)

37790 (RFP-1543) POSSIBILITY OF HAZARDOUS ENVIRONMENTAL PLUTONIUM RELEASES. Hunt, Douglas C. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 14 Apr 1971. Contract AT(29-1)-1106. 37p. Dep. NTIS.

A study was made of the possible hazard outside an enclosure which could be caused by uncontrolled oxidation of plutonium within the enclosure. The report first reviews the existent observational data on such restricted plutonium release and then constructs a release model relating the free-release source strength (i.e., the source strength outside the enclosure) and the parameters describing the release. Based on both the observational data and the model calculations, the conclusion follows that restricted release is unlikely to lead to dangerous free releases of a plutonium aerosol. The model calculations specifically show that the maximum credible accident assumed would be safe by about 2 to 5 orders of magnitude. However, the calculations indicate that maximizing either the plutonium release rate or the asymptotic temperature reached in an enclosure can cause a free release exceeding the safe rate. (auth)

37791 (SZS-1/71) RESULTS OF RADIATION PROTECTION MONITORING IN THE BIOSPHERE OF FALLOUT RADIOACTIVITY IN THE GERMAN DEMOCRATIC REPUBLIC, 1969. Moldenhawer, F.; Schulze-Wollgast, U. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Jan 1971. 50p. (In German). Dep. NTIS (U. S. Sales Only).

In 1969 the results of fallout monitoring showed a further decrease of the ^{90}Sr and ^{137}Cs contamination of nearly all environmental samples. On the average the concentration of ^{90}Sr decreased more heavily than that of ^{137}Cs. The decrease of ^{90}Sr contamination of fallout, several plants (lucern, rye and wheat grain, potatoes) and milk was most marked. The ^{137}Cs contamination of several plants (turnip, lucern, potatoes) decreased too, whereas that of milk, total diet, grass and rye grain was unchanged in comparison with 1968. (auth)

37792 (UCLA-12-816) PERSISTENCE OF RADIONUCLIDES IN SOIL, PLANTS, AND SMALL MAMMALS IN AREAS CONTAMINATED WITH RADIOACTIVE FALLOUT. Romney, E. M.; Rhoads, W. A.; Wallace, A.; Wood, R. A. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1970]. Contract AT(04-1)-Gen-12. 23p. (CONF-710501-2). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

The persistence of radionuclides in soil, plants, and small mammals was investigated periodically in areas contaminated with fallout from above-ground nuclear detonations at the Nevada Test Site. Study sites were established at various locations out to about 225 km from ground zero. Emphasis was placed upon the movement of ^{90}Sr and ^{137}Cs from abiotic to biotic components. Several neutron activation products also were studied in fallout areas located within 5 km of nuclear excavation tests. Radionuclides continued to be taken up through plant roots in small amounts as time progressed, and some continued to be deposited on foliage as resuspended dust particles. The inhalation route of entry became less important with passing time, whereas ingestion continued to be the most important route through which radionuclides entered small mammals living in old fallout areas. Long-lived ^{90}Sr accumulated primarily in bone tissue while ^{137}Cs accumulated in muscle and soft tissue. (auth)

37793 (UCRL-73085) IMPORTANCE OF TRITIUM IN THE CIVIL DEFENSE CONTEXT. Martin, J. R.; Koranda, J. J. (California Univ., Livermore. Lawrence Radiation Lab.). 8 Mar 1971. 15p. (CONF-700909-4). Dep. NTIS.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

The importance of tritium in the civil defense context is assessed by comparing the dose rate and 30-year dose integral for tritium from fusion with the external dose of gamma-emitting fission products. The tritium dose was computed by assuming equilibration of fallout tritium with water in the biosphere and with body water of man. The fission product gamma dose for late-time dose significant nuclides is tabulated in terms of R/hr/kt/mi^2 as a function of time. Tritium is shown to be relatively unimportant in the civil defense context when compared with the external gamma dose from an equal yield of fission products. (auth)

Dosimetry and Monitoring

Refer also to abstracts 37306, 37519, 37575, 37578, 37622, 37653, 37699, 37710, 37712, 37717, 37742, 37758, 37832, 37851, 37865, 38173, 38523, and 39273.

37794 (BNWL-B-63) RADIOLOGICAL SIGNIFICANCE OF 100-N SANITARY WATER. Fisher, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1971. Contract AT(45-1)-1830. 21p. Dep. NTIS.

Various methods for estimating the radiation dose to the gastrointestinal tract of man from radionuclides in drinking water were compared. Estimates based on total beta measurements appear to be more accurate than those based on the measured concentration of a single radionuclide. A formula is included for calculating the average total beta dose to the gastrointestinal tract. (C.H.)

37795 (BNWL-SA-3712) THERMOLUMINESCENT DOSIMETRY OF AQUATIC ORGANISMS. Watson, D. G.; Templeton, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1971. Contract AT(45-1)-1830. 12p. (CONF-710501-18). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Lithium fluoride thermoluminescent dosimeters were employed to estimate the radiation exposure to Columbia River organisms downstream from the effluent outfalls of the Hanford plutonium producing reactors. Highest dose measurements were made in the river benthos. Observed dose was inversely related to distance downstream from the effluent outfalls. Radionuclides in suspension or solution in the river water contributed significantly to the total radiation exposure to both fish and benthic organisms. The dose to fish homogenate and intact fish kept frozen during dosimeter exposure was generally inversely related to fish size. This relationship did not hold for the major gamma emitting nuclides contained in the fish carcass, but appeared to be associated with the body burden of radiophosphorus. (auth)

37796 (CEA-N-1364) [WORK OF AEROSOLS AND MINES GROUP IN 1969]. Billard, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1970. 57p. (In French). Dep. NTIS (U. S. Sales Only).

Topics covered are the following: the collection of charged aerosols; the production of calibrated aerosols of polystyrene and the measurement of the efficiency of Nuclepore membranes; methods for sampling and studying aerosols using electron microscopy; radiation protection in uranium mines; atmospheric

pollution and ultrafine particles; development of Royco spectrophotometer associated with a multi-channel selector; development of generator of zinc sulfide aerosols; determination method for zinc sulfide aerosols; trapping of iodine and methyl iodide at high temperatures; distribution and trapping of fission products at high temperatures, Eurydice loop; rare gases trapping by absorption in fatty matter; study of a diving-suit for the protection against tritium and tritiated water. (France)

37797 (EUR–4605) RESULTS OF ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS IN THE COMMUNITY COUNTRIES IN 1969: AIR–FALLOUT–WATER. (European Communities, Luxembourg. Commission). 1971. 78p. (In several languages). Dep. NTIS (U. S. Sales Only). EUR DM 7,20.

The report comprises an introductory note and three sections dealing with measurements of radioactivity in the air at ground level, in fallout and in water. Most of these measurements relate to total beta radioactivity. The measurement results for certain specific radionuclides are also given as well as the amount of precipitation observed at fallout sampling stations. Graphs are given to show the pattern followed throughout the year, a comparison being drawn with the development over the years 1962, 1963, 1964, 1965, 1966, 1967, and 1968 as well as with the situation in 1969 in the United States and Canada. (auth)

37798 (EUR–4612, pp 327-51) EXPERIENCE WITH HANDLING TRANSURANIUM ELEMENTS AT LOS ALAMOS. Penneman, R. A.; Johnson, LaMar J. (Los Alamos Scientific Lab., N. Mex.).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

A summary is given of experience accumulated at Los Alamos in handling large quantities of plutonium-239, plutonium-238, americium-241, and lesser amounts of the heavier transuranium elements, including californium-252. Some accidents which have occurred at Los Alamos are discussed. Urine assay results to determine plutonium body burdens show only 17 out of more than 5000 exposed people are estimated to have more than the maximum permissible body burden. A lung counter developed at LASL is capable of detecting transuranium elements in the lungs of an individual, e.g., levels of about 3 nCi of plutonium-239 or 0.02 nCi of americium-241. Lung count results on individuals activity involved with handling plutonium and americium isotopes showed only a single individual with a maximum permissible lung burden. (auth)

37799 (EUR–4612, pp 383-401) PARTICLE SIZE DISTRIBUTIONS OF SOME TRANSURANIUM ELEMENT COMPOUNDS AND THEIR DEPOSITION IN THE RESPIRATORY TRACT AFTER INHALATION. Vaane, J. P.; de Ras, E. M. M.; von Brandenstein, Chr. (European Inst. for Transuranium Elements, Karlsruhe (West Germany)).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Aerosol samples of plutonium, americium and curium were collected on glass fibre filters by drawing air from glove boxes, and from laboratories after accidental releases. The size distributions of the particles on these filters were determined by autoradiographical methods using nuclear track films. Samples from different compounds and different types of work areas were collected in order to find a relationship between the size of the particles and their origin. In each case the distribution of the activity in the human respiratory tract was calculated from the particle size distribution, applying the new lung model of the International Commission on Radiological Protection. As expected the particle size depends on the physical properties of the radioactive aerosol material. This means that the percentage of the inhaled material remaining in the lungs in case of an inhalation could more or less be predicted for different types of work areas. A further step would then be to calculate the size distribution for each type of the various materials being handled in a nuclear establishment in preparation for a quick estimation of the lung deposition risk in cases of accidental inhalation. (auth)

37800 (EUR–4612, pp 437-68) INTERPRETATION OF DATA ON INTERNAL PLUTONIUM CONTAMINATION. Heid, K. R.; Jech, J. J.; Andersen, B. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

A program for evaluation of personnel exposure resulting from internally deposited radionuclides at a nuclear plant at Richland, Washington is briefly described. Techniques utilizing in-vivo measurements, the latest ICRP Lung Model Concept, and other data to evaluate internally deposited plutonium resulting from either inhalation or ingestion are discussed in detail. A detailed evaluation of both an inhalation and an ingestion case is included. (auth)

37801 (EUR–4612, pp 469-82) PROGRESS IN INSTRUMENTATION AND CALIBRATION TECHNIQUES FOR THE ASSESSMENT OF LUNG BURDENS OF ^{239}Pu. Newton, D.; Rundo, J.; Taylor, B. T. (Atomic Energy Research Establishment, Harwell (England)).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Highly sensitive equipment is necessary for the measurement of lung deposits of plutonium-239 at levels below the maximum permissible burden of 16 nCi, since the weak low energy x rays of uranium provide the only radiation detectable using counters external to the body. The development of gas filled proportional counters for this purpose are described. In the interpretation of spectra from contaminated subjects difficulties arise because the low energies of the x rays, and their consequent severe attenuation in body tissues, mean that the intensity of radiation escaping from the chest will show a marked dependence on body build. The attenuation in the chest wall has been studied in volunteer subjects who inhaled aerosols labelled with protactinium-233 or palladium-103 as simulators of plutonium-239, and the results of these experiments are discussed. (auth)

37802 (EUR–4612, pp 531-46) STUDY OF TWO CASES OF ^{241}Am CONTAMINATION. Jeanmaire, L.; Ballada, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Two persons became contaminated by ^{241}Am when opening a sealed ampoule containing the radioelement in solution. The progression of contamination with time was studied by the direct measurements using a sodium iodide detector and a multi-channel analyzer. During this time, excretion was measured in urine and feces. A critical examination is made of both measurement methods. (auth)

37803 (EUR–4612, pp 547-58) MEASUREMENT OF CONTAMINATION OF EXCRETA AS A MEANS OF DETERMINING THE BODY BURDEN OF PERSONS WORKING ON THE ^{227}Ac PRODUCTION PROGRAMME. Dulcino, J.; Weyers, C.; Baton, J.; Hofkens, K.; Koch, G. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). (In French).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

As part of the program for producing actinium-227 from radium-226, now in progress at the Nuclear Energy Research Center, it has been found necessary to institute an inspection program for monitoring the internal contamination of personnel. It was felt appropriate to supplement the information obtained from in vivo measurements by further information from tests on excreta, which meant determining the amounts of key elements handled, i.e. actinium-227, thorium-228 and, incidentally, radium-226 itself, contained in samples of urine and, where necessary, in feces. For this purpose, a chromatographic method was devised for the detection of actinium and thorium, while the radon method is being used for the detection of radium-226. Moreover, the measurement of radon in the air exhaled makes it possible to estimate the body burden of radium. A bibliographic study was carried out in order to interpret the results obtained as effectively as possible. (auth)

37804 (EUR–4612, pp 631-46) IMMEDIATE AND LONG-TERM MEASURES TAKEN IN FOLLOWING THE CONTAMINATION OF PERSONNEL BY ^{241}Am AND ^{242}Cm. Dulcino, J.; Colard, J.; Nuttinck, D.; Luysterborg, J.; Koch, G. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). (In French).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Immediately after the BR-2 reactor incident was discovered ^{241}Am and ^{242}Cm were identified in samples by means of alpha spectrometry. As the incident was discovered approximately one month after it happened many persons who had spent some time in the installations, either in the course of their work or inciden-

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tally, had to be considered as potentially contaminated. In order to screen the various persons and to take the appropriate measures in individual cases with the least possible delay, a technique was applied for rapid overall measurement of alpha-emitters in the urine. Two hundred and fifty samples were analyzed during the first fortnight following the discovery of the contamination. The lung dose due to ^{241}Am was monitored by means of a thin NaI detector and that due to ^{242}Cm by means of a proportional counter. A program of routine inspection of personnel contamination was instituted during the operations of decontamination and start up of the reactor. For this purpose a specific and more sensitive method of chromatographic analysis of urine was developed, and a literature survey permitted a more effective interpretation of the levels of excreta contamination. (auth)

37805 (NIRS-RSD-28) RADIOACTIVITY SURVEY DATA IN JAPAN. (National Inst. of Radiological Sciences, Chiba (Japan)). Aug 1970. 15p. Dep. NTIS (U. S. Sales Only).

Data from radioactivity surveys conducted throughout Japan by the National Institute of Radiological Sciences are presented. Included among the data are: external exposure rates due to natural radiation in the Tohoku district of Japan during 1969 and 1970; dietary data including the ^{90}Sr and ^{137}Cs contents of rice, a standard diet, and the total diet in Japan during 1968 and 1969; and the monthly deposition of ^{90}Sr and ^{137}Cs in precipitation in Japan during 1969 and 1970. The cumulative deposition for this period is also given. All data are presented in tabular form. (ERB)

37806 (NIRS-RSD-29) RADIOACTIVITY SURVEY DATA IN JAPAN. (National Inst. of Radiological Sciences, Chiba (Japan)). Nov 1970. 18p. Dep. NTIS (U. S. Sales Only).

Data from radioactivity surveys conducted throughout Japan by the National Institute of Radiological Sciences are presented. Included among the data are: radioisotope content of air borne dusts during 1969 and 1970; ^{90}Sr and ^{137}Cs content of raw and treated waters and standard and total diets during 1969 and 1970; and the ^{90}Sr, ^{106}Ru, ^{137}Cs, and ^{144}Ce contents of river sediments and soils during 1969. Also included in this report are data on the gross β-radioactivity in rain and dry fallout and in the upper atmosphere following the eleventh nuclear test of the People's Republic of China in October, 1970. All data are presented in tabular form. (ERB)

37807 (NP-18729) STUDIES IN THE HIGH BACKGROUND AREAS IN KERALA STATE: DEFINITION OF THE POPULATION AND PRELIMINARY DOSIMETRIC DATA. Gopal-Ayengar, A. R.; Sundaram, K.; Mistry, K. B.; Sunta, C. M.; David, M. (Bhabha Atomic Research Centre, Bombay (India). Modular Labs.). [nd]. 13p. Dep. NTIS (U. S. Sales Only).

It was found that a strip of 55 kilometers along the coast of Kerala contained patches of radioactive sand. The area is characterized by a high density of populations and a concentrated distribution of monazite. Thorium and its decay products contribute to the high background radiations and during the decay of thorium, alpha, beta, and gamma radiations are released. Human populations are subjected to radiation exposures from external radiations caused by beta and gamma radiation from natural uranium and thorium in monazite, beta and gamma radiation from radon and thoron and their decay products in air, and internal exposures from deposition of the radioactive materials through ingestion and inhalation. A demographic survey was conducted on three occupational groups representing individuals employed elsewhere, individuals totally employed in the area, and fishermen. Data were analyzed for sex ratio among offspring, ratio of abortions and still births to total pregnancies, ratio of congenital abnormalities to total live births, and infant mortality rates. Thermoluminescent dosimeters were developed for measuring dose to individuals in the population; the data indicate that the level of radioactivity decreases from south to north along the coast. A close similarity between environmental dose and personal radiation exposure was observed. The difficulties of estimating genetic damage are discussed. (H.L.W.)

37808 (RD/B/M-1022(App.)) GAMMA AND BREMSSTRAHLUNG DOSE FROM ^{85}Kr IN AIR. Harvey, John (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). [1967]. 3p. Dep. NTIS (U. S. Sales Only).

The γ and bremsstrahlung doses to the skin and the underlying organs of man from ^{85}Kr in air are calculated. It was determined that the bremsstrahlung dose to shallow organs is about 0.2% of the β dose to the skin and the γ dose is roughly 1.0% of the β dose to the skin. Calculations and appropriate references are given. (E.R.B.)

37809 LOW-DOSE-RATE IRRADIATION OF MAMMALIAN CELLS WITH RADIUM AND ^{252}Cf. A COMPARISON OF EFFECTS ON AN ACTIVELY PROLIFERATING CELL POPULATION. Hall, Eric J.; Rossi, Harald H.; Roizin, Laurie A. (Columbia Univ., New York). Contract AT(30-1)-2740. Radiology; 99: 445-51(May 1971).

Cultured Chinese hamster cells were exposed to a range of low dose-rate γ radiation from radium-226 and mixed γ and fast neutrons from californium-252. From the results obtained, it was possible to calculate the biological effectiveness of the mixed neutron and gamma-ray emission from ^{252}Cf relative to radium-226 γ rays. It was found that this RBE increased as the dose-rate was decreased, according to the relationship RBE of ^{252}Cf compared to radium-226. This fact, together with the high RBE of neutrons, calls for extreme caution in the handling and clinical use of ^{252}Cf. (auth)

37810 TIME-SHARING COMPUTERS FOR TREATMENT PLANNING IN RADIATION THERAPY. Hendee, William R.; Cadigan, Robert A. (Univ. of Colorado, Denver). Radiology; 99: 423-8(May 1971).

In many institutions, use of digital computers for treatment planning in radiation therapy is limited by the unavailability of computers and the scarcity of personnel with programming experience. These limitations may be overcome by using commercially available time-sharing computers with a teletype terminal connected by a telephone line to a remote computer in which dosimetric programs for external beam and implant therapy are stored. These programs may be used routinely for inexpensive display of dosimetric data for patients undergoing single-field, multifield, rotation, and implant radiation therapy. (auth)

37811 SMALL-SCALE COMPARISON OF FILM BADGES AND THERMOLUMINESCENT DOSIMETERS. PRELIMINARY REPORT. Crosby, E. H. (Guthrie Clinic, Sayre, Pa.). Radiology; 99: 429-32(May 1971).

Ten persons from three different radiology departments wore film badges and thermoluminescent dosimeters side by side routinely for several months. There were 16 film : TLD ratios in which the film badge exposure was reported as at least three times that of the TLD exposure. It was not uncommon for the film-badge exposure to read five or more times that of the TLD dosimeter among personnel working exclusively or predominantly in diagnostic radiology. (auth)

37812 RADIATION DOSIMETRY IN FULL-CHEST TOMOGRAPHY. Buchignani, John S.; Wagner, William M.; Howley, John R. (National Institutes of Health, Bethesda, Md.). Radiology; 99: 175-6(Apr 1971).

Lithium fluoride dosimeters were used to measure the exposure doses to various critical organs during routine full-chest tomography. The results are tabulated. The doses to the thyroid and lens are reduced dramatically by conducting the examination with the patient in the prone position. (auth)

37813 EVALUATION OF PHYSICIAN EXPOSURE DURING CARDIAC CATHETERIZATION. Wold, G. J.; Scheele, R. V.; Agarwal, S. K. (Bureau of Radiological Health, Rockville, Md.). Radiology; 99: 188-90(Apr 1971).

The x radiation exposure received by the examining physician during cardiac catheterization was measured at 13 body locations. Results thus far indicate that the lens of the eye (forehead) receives the highest average exposure per procedure of those parts of the body limited to an occupational exposure of 5 rems a year, with similar levels at the forearms and hands. (auth)

Radiation Protection

Refer also to abstracts 39176–39178.

37814 (EUR-4612) RADIATION PROTECTION PROBLEMS RELATING TO TRANSURANIUM ELEMENTS. Seminar [held at] Karlsruhe (W. Germany), September 21–25, 1970. (European Communities, Luxembourg. Commission). Feb 1971. 660p. (In several languages). (CONF-700930). EUR $20.00.

Separate abstracts were prepared on 30 papers. Two papers were abstracted and appeared in NSA previously. (C.H.)

For abstracts of individual papers see: 37308, 37404, 37439–37441, 37719, 37720, 37780–37784, 37798–37804, 37815–37822, 37832, 38974, and 38975.

37815 (EUR-4612, pp 99-113) APPLICATION OF TRANSURANIUM ELEMENTS AND RELATED SAFETY ASPECTS. Drent, W.; Hunzinger, W. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

The paper focuses on the application of transuranium elements as radiation and energy sources where high energy densities are

required and where the choice of the source is fixed by several limiting factors such as e.g. space or weight. It enumerates those transuranium elements used in prototypes or proposed for use in future projects. The related safety problems are manifold and difficult, especially as transuranium elements are more and more applied in industry and public services by persons not used to working with radioactive materials. For specific applications very few standard regulations are established for ensuring adequate protection for the users. Appropriate proposals related to the various health and safety aspects are outlined. (auth)

37816 (EUR-4612, pp 115-41) ^{238}Pu SOURCES FOR CARDIAC PACEMAKERS. Berger, R.; Boucher, R.; Jampsin, B.; Devillers, C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

The radiation protection and safety concepts for plutonium-238 capsules for cardiac pacemakers are described according to the following: dose rate equivalents, thermo-mechanical stresses, chemical corrosion. This survey is supplemented by experimental results. (auth)

37817 (EUR-4612, pp 291-325) TRANSURANIUM ELEMENT HEALTH PHYSICS AND SAFETY AT OAK RIDGE NATIONAL LABORATORY. Haynes, C. E. (Oak Ridge National Lab., Tenn.).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

As part of the national heavy element program the Oak Ridge National Laboratory produces, separates, and purifies research quantities of americium, curium, berkelium, californium, einsteinium, and fermium. A wide spectrum of research and development activities with these elements and their isotopes is carried out. Associated with the transuranium element production and research programs are the intrinsic internal and external radioactivity hazards of these materials. Because of these hazards there are corresponding requirements for certain controls, including appropriate containment, shielding, and monitoring surveillance throughout all steps of each operation or investigation. The radiation protection program is described. (auth)

37818 *(EUR-4612, pp 363-82) EFFECT OF THE IRRADIATION OF NUCLEAR FUEL ON THE INTERNAL DOSIMETRY OF PLUTONIUM.* Ward, F. A.; Lynn, J. C. (United Kingdom Atomic Energy Authority, Sellafield (England). [Production Group]).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

The changes in isotopic composition of the plutonium content of nuclear fuel with irradiation are considered. The most serious hazard, in the context of internal dosimetry, is the production of plutonium-241. This radionuclide does not represent a significant hazard itself but it decays to americium-241 which has a radiotoxicity comparable to that of the alpha-emitting plutoniums. Two uptake models are considered, the chronic long-term uptake arising from routine operations at (MPC) levels, and the single acute intake which could arise as a result of abnormal or accident conditions. Using ICRP parameters it is shown that, for plutonium compounds not readily soluble in body fluids, the effect of irradiation up to 5,000 MWd/Te is insignificant in both the chronic and acute uptake cases. However, in the case of readily soluble compounds the effect of the presence of plutonium-241 increases with irradiation in chronic and acute uptakes. In the chronic case it is concluded that assessments based upon the summation of MPBBs are satisfactory although they are pessimistic where the overall period of uptake is much less than 50 years. In the acute case the summation of MPBBs is more pessimistic and it is proposed that dose equivalent or dose equivalent rate, to bone, should be used as the criterion for assessing the gravity of a case. (auth)

37819 (EUR-4612, pp 403-18) RADIATION PROTECTION IN A REPROCESSING PLANT AND STUDY OF THE DIFFERENT SAFETY FACTORS. Peyresblanques, H. (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). (In French).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Safety in a radiochemical processing plant is dependent on technical and psychological factors. The different aspects are reviewed and several typical accidents are studied as regards their origin, their consequences, and the means to prevent them. The review is supplemented by statistical data on risk distribution and doses absorbed by personnel working in reprocessing plants. (auth)

37820 (EUR-4612, pp 421-35) PLUTONIUM BIO-ASSAY LABORATORY AT THE CASACCIA NUCLEAR CENTRE. Testa, C.; Masi, G.; Marchionni, V. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

A special radiotoxicological laboratory was built at the Casaccia Nuclear Center for the biological control of the workers engaged in handling plutonium. This radiotoxicological laboratory is separated from other laboratories and it is completely self-sufficient as concerns reagents and equipment in order to obtain a very low alpha background. Different analytical methods for the determination of plutonium in the urine were tested and two suitable techniques were chosen either for accurate routine controls and for rapid checks. The routine urine analysis consists in a wet mineralization, a plutonium coprecipitation, a passage on an anion exchange resin column, an electroplating procedure on small stainless steel discs, an alpha counting by an automatic solid state detector; the final recovery is 78% ± 22, with a sensitivity limit of 0.04 pCi per liter of urine. The creatinine determination is used to obtain the 24 hours urinary excretions. Some techniques for nose blows and feces controls with different sensitivity limits were also tested. The laboratory is equipped with an alpha spectrometry apparatus to be used in the cases of values exceeding the reference levels, with some battery operated portable alpha detectors for emergency cases and with two special instruments to detect the alpha particles and the 17 keV x rays of plutonium in contaminated wounds: one of those instruments is portable and battery operated for emergency cases. (auth)

37821 (EUR-4612, pp 483-514) RADIOLOGICAL PROTECTION OF WORKERS HANDLING TRANSURANIUM ELEMENTS. Holliday, B. (Atomic Energy Research Establishment, Harwell (England)).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

The primary purpose of routine environmental monitoring is to check the working environment and confirm that operating conditions are satisfactory. The results of environmental monitoring in a facility handling transuranium elements can be used to achieve this purpose and to define a routine individual monitoring program. Significant changes in the averages of the monitoring levels over an extended period can and should be used as the basis for regular reviews of the scheduled routine program. Routine monitoring results also provide the primary trigger for special investigation of the individual in terms of retention of transuranium elements in the body. Derived working levels and investigation levels are proposed for assessing environmental conditions and triggering special investigations respectively. (auth)

37822 (EUR-4612, pp 585-93) EXPERIENCE ACQUIRED FROM INCIDENTS WITH TRANSURANIUM ELEMENTS. Kiefer, H.; Moehrle, G. (Kernforschungszentrum, Karlsruhe (West Germany)). (In German).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

A number of incidents with transuranium elements at the Karlsruhe Nuclear Research Center are described. The experience acquired in radiation protection from the technical, physical, and medical points of view is presented. (auth)

37823 (KFK-1365) ANNUAL REPORT 1970. Division of Radiation Protection and Safety. Kiefer, H.; Koelzer, W. (Kernforschungszentrum, Karlsruhe (West Germany)). Feb 1971. 182p. (In German). Dep. NTIS (U. S. Sales Only).

The different duties of the Radiation Protection and Safety Department are described, the results of routine measurements for 1970 are listed, and recent results of investigations and developments in the Working Groups of the Department are covered. (auth)

37824 (LA-4400) LOS ALAMOS HANDBOOK OF RADIATION MONITORING. Healy, John W. (Los Alamos Scientific Lab., N. Mex.). 1970. Contract W-7405-eng-36. 219p. GPO $1.25.

The radiation protection program at Los Alamos Scientific Labo-

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ratory is reviewed. Methods used for radiation monitoring are described in detail. Data are included on the maximum permissible concentrations of approximately 200 radioisotopes in air and water, and data on maximum permissible body exposure are included when relevant. (C.H.)

37825 (RT/PROT-(71)7) DERIVED OPERATING LIMITS OF SURFACE CONTAMINATION. Moccaldi, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 25 Jan 1971. 32p. (In Italian). Dep. NTIS (U. S. Sales Only).

Derived working limits of surface radioactive contamination are proposed for the use of health physicists in the measurement of surface contamination. The most important radiological risks due to surface contamination are pointed out. Working limits, determined on the base of theoretical and experimental hypothesis, are presented. (auth)

37826 (STI/DOC-10/125) IAEA RESEARCH CONTRACTS. Eleventh Annual Report. Technical Reports Series No. 125. (International Atomic Energy Agency, Vienna (Austria)). 1971. 294p. IAEA $7.00.

Summaries are presented of the research projects sponsored by and under contract to the International Atomic Energy Agency. The projects are grouped into three categories as follows: nuclear technology including nuclear power and reactors, waste management, and physics and chemistry; radioisotopes and radiation applications including agriculture, food technology, industry, medicine, and hydrology; and protection of man and his environment including radiation biology, health physics and radiation protection, environmental research, and safeguards. (E.R.B.)

37827 STATUS OF RADIATION PROTECTION FOR FIRE DEPARTMENTS. Schenk, Max (Feuerwehr der Stadt, Essen). Tech. Ueberwach.; 10: 414-16(Dec 1969). (In German).

The radiation protection divisions of the German fire departments aim at elimination of hazards created by peaceful application of nuclear energy. Nuclear power plants are beyond their field of responsibility. The principles of handling fires and accidents involving radiation, proper equipment with detection devices, tables for permissible duration of stay in radiation areas, theoretical plans for operation, coordination of fire protection with radiation protection, and development of a contamination protection suit are discussed. (H.B.G.)

37828 ACCEPTABLE GONADAL SHIELD. Brown, Reynold F.; Burnett, Bruce M.; Benary, Vili (Univ. of California, San Francisco). Radiology; 99: 265-9(May 1971).

There is evidence that gonadal shielding is not practiced as recommended in a significant number of pertinent roentgen examinations. Social acceptability may be an important factor in such a device. An acceptable shield has been designed and tested; its further improvement and use are recommended. (auth)

Safety Procedures

Refer also to abstracts 37567 and 37746.

Legal Aspects

37829 (A/CONF.49/P-89) TRENDS IN FEDERAL AND STATE LEGISLATION IN THE UNITED STATES FOR THE PROTECTION OF THE ENVIRONMENT AND THE REGULATION OF NUCLEAR POWER PLANTS. Shapar, Howard K. (Division of Licensing and Regulation (AEC), Washington, D. C.). Sep 1971. 23p. (CONF-710901-22). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Public opinion in the U.S.A. toward preservation of the environment has resulted in a number of wide-ranging legislative proposals designed, in some cases, to effect root changes in governmental techniques of environmental protection. The electric power industry, and the nuclear power segment in particular, has felt the impact of these developments. A review of these trends is made in the context of all the significant environmental considerations without regard to the source of the environmental impact, and the existing legislative framework, including the Atomic Energy Act, the Federal Power Act, the Rivers and Harbors Act, the Federal Water Pollution Control Act, the National Environmental Policy Act of 1969, and the Water Quality Improvement Act of 1970. The divergent approaches reflected in these two last-named acts, and the interaction between the two, are discussed. Important organizational changes, centralizing federal pollution control responsibilities within the federal government, became effective in 1970. Among other changes, the USAEC's functions in setting general standards for radioactivity in the general environment are now performed by the new Environmental Protection Agency. During 1970 the problem of coordination between electric power requirements and environmental preservation received intensive study by the Office of Science and Technology. This study eventuated in a report recommending the establishment of new industry responsibilities and institutional arrangements designed to meet this problem. This is an area where additional legislative action may be anticipated. Other possible areas for new legislation, in the radiation control field, specifically, are the division of responsibilities between the states and the federal government and a restructuring of the review and hearing processes for facility licenses. (auth)

Medicine

Protective Substances

Refer also to abstracts 37857, 37859, 37882, 37883, 37900, and 37915.

37830 POSTIRRADIATION VAGINITIS. AN EVALUATION OF PROPHYLAXIS WITH TOPICAL ESTROGEN. Pitkin, Roy M.; Van Voorhis, Lee W. (Univ. of Iowa, Iowa City). Radiology; 99: 417-21(May 1971).

The prophylaxis of postirradiation vaginitis with topical estrogen cream was studied immediately upon completion of therapy in a controlled double-blind investigation of 93 patients with cervical carcinoma. Estrogen-treated subjects, in comparison with controls, had statistically significantly less dyspareunia, alterations in vaginal epithelium, and narrowing of vaginal caliber. Coitus, independent of estrogen treatment, was associated with a more nearly normal vaginal caliber, but a cause-and-effect relationship was not clear from the present data. It is concluded that the postirradiation use of estrogen could be expected to lower the incidence of postirradiation vaginal complications. (auth)

37831 ALTERATION OF POSTIRRADIATION HYPOTENSION AND INCAPACITATION IN THE MONKEY BY ADMINISTRATION OF VASOPRESSOR DRUGS. Miletich, D. J.; Strike, T. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Proc. Soc. Exp. Biol. Med.; 137: No. 1, 111-15(May 1971).

The effect of vasopressor drugs on the early hypotension and incapacitation observed in monkeys following a 4-krad pulsed dose of mixed gamma-neutron radiation was investigated. Seven monkeys received only the 4-krad dose of radiation and served as controls. Norepinephrine or angiotensin was administered to five other monkeys by intravenous infusion from 5 min prior to irradiation until death, except that infusion was temporarily interrupted several times after irradiation of the animals. Blood pressure was continuously monitored in all animals. Drug-induced blood pressure elevation prior to irradiation did not prevent the characteristic early postirradiation fall in mean blood pressure, but severity of the resulting hypotension was reduced. Cessation of drug infusion after irradiation resulted in a rapid drop in blood pressure with the animal becoming incapacitated (loss of consciousness) when mean blood pressure fell below a critical level of about 50 mm Hg. After drug infusion was resumed, consciousness returned as the blood pressure rose above the critical level. This sequence was repeated several times before the animal failed to respond to drug administration and died abruptly in a hypotensive state. Five other monkeys were given a single intravenous injection of ephedrine or amphetamine 1 hr before irradiation; these animals received no further treatment. Ephedrine administration appeared to be as effective at maintaining satisfactory postirradiation blood pressure and abolishing ETI as norepinephrine and angiotensin. (auth)

Radiation Sickness and Injuries

Refer also to abstract 37783.

37832 (EUR-4612, pp 259-71) CASE OF ^{239}Pu INHALATION. Alderhout, J.; Hunzinger, W. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

From the results of urine analyses of personnel known to have entered an air contaminated zone at Eurochemic in November 1969, it was apparent that one person could have slightly exceeded the maximum permissible body burden for ^{239}Pu. The plutonium urinary excretion of this case, which was treated a few times with DTPA, was followed in order to obtain a more exact

estimation of the internal radiation dose. In addition some analyses of feces and direct lung counting were carried out. The results of these analyses are reported and discussed. (auth)

Radiodiagnosis

Refer also to abstracts 37585, 37604, 37605, 37708–37710, 37812, 37813, and 37828.

37833 (A/CONF.49/P-92) RECENT ADVANCES IN DIAGNOSTIC NUCLEAR MEDICINE. Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore, Md.); Rupp, Arthur F. (Oak Ridge National Lab., Tenn.). Sep 1971. 22p. (CONF-710901-42). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Progress in the field of diagnostic nuclear medicine has been rapid during the last 10 years. Radiodiagnostic achievements during this time have been of a technological, clinical, and conceptual nature. An important new development in nuclear medicine is the application of computers in diagnostic studies for making calculations, rapid access to previous studies, image processing, data acquisition, and simulation. Another important contribution to nuclear medicine is organ scanning or imaging in which a radioisotope is introduced into the body and its distribution in an organ or tissue is quantitatively determined and displayed or printed out to facilitate the diagnostic procedure. In addition to their diagnostic role, radioisotopes are also used in making a prognosis and in evaluating treatment. The development and use of new short-lived radioisotopes and new radiopharmaceuticals for function studies as well as diagnostic applications is discussed. The advantageous application of automation in in vitro clinical studies (i.e., the use of radioactive tracers in the automated detection of bacterial growth in blood cultures) is becoming a reality with new technological advances. (E.R.B.)

37834 (ORO–2401-29) DATA ACQUISITION SYSTEM FOR USE IN NUCLEAR MEDICINE. Erickson, J. J.; Lagan, J. E.; Brill, A. B. (Vanderbilt Univ., Nashiville, Tenn.). [1970]. 8p. (CONF-710425–1). Dep. NTIS.

From Symposium on sharing of computer technology in radiation therapy and nuclear medicine; Oak Ridge, Tenn. (2 Apr 1971).

The design and operation of a digital data acquisition and processing system for rapid analysis of data from clinical radioisotope tracer studies are described. The system provides the capability of acquiring data both from an Anger camera and from a rectilinear scanner. The advantages of digital computers and digital data processing systems for the rapid analysis of data from sophisticated dynamic radioisotope function studies are discussed. (C.H.)

37835 (ORO–2401-33) PHYSICAL CONSIDERATIONS FOR DUAL RADIONUCLIDE IMAGING TECHNIQUES. Erickson, Jon J.; Brill, A. Bertrand (Vanderbilt Univ., Nashville, Tenn.). Apr 1970. Contract AT(40-1)-2401. 47p. (CONF-700516–5). Dep. NTIS.

From first biennial conference on quantitative organ visualization in nuclear medicine, Miami, Fla.

Clinical dual radioisotope tracer studies may be performed using two different radioisotopes, two different compounds labeled with the same radioisotope, or a single radioisotope with measurements made at different times to reveal tissue distribution as a function of time. The biological and physical factors that influence the choice of technique and methods used for data collection, storage, analysis, and display are discussed. Emphasis is placed on digital computer analysis of radioisotope scan data. (C.H.)

37836 (TID–3319(Suppl.3)) NUCLEAR MEDICINE. Bibliography from Nuclear Science Abstracts. Volume 24. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Jun 1971. 281p. Dep. NTIS.

Annotated citations are presented for 1078 literature items in the fields of clinical and experimental radiodiagnosis and radiotherapy for which abstracts were included in Nuclear Science Abstracts, Volume 24 for 1970. Each reference includes all the index entries selected for the item. (C.H.)

37837 QUANTITATIVE METHOD OF EVALUATING FOCUSED COLLIMATORS. Wyper, D. J.; Gillespie, F. C. (Western Regional Hospital Board, Glasgow). J. Nucl. Med.; 12: 197-203(May 1971).

The resolution of a multihole, focused collimator has been described by the modulation transfer function (MTF), which in practice is normally calculated from the measured line-spread function. Unfortunately this method of description, while overcoming the major defects of the earlier methods, appears itself to suffer from two fairly important disadvantages. The first, and most obvious, is its lack of simplicity which arises from the use of a continuous function rather than single parameters. The second is that it gives no indication of which frequencies within the spatial frequency domain are most important for the collimator, and consequently does not allow the resolution at these frequencies to be immediately assessed. An expression was derived which defines the point in the frequency domain at which the performance of a particular multihole collimator is most significant. The wavelength corresponding to this spatial frequency is called the comparative optimum response wavelength, and the value of the MTF at this wavelength is called the index of modulation of the collimator. It is suggested that the comparative optimum response wavelength together with the index of modulation can be used to describe the resolution of a multihole collimator for a given photon energy in a simple yet meaningful way, and that these two together with the plane source sensitivity can be used to describe the overall performance of the collimator. (C.H.)

37838 USE OF ^{135m}Ba AND ^{131}Ba AS BONE-SCANNING AGENTS. Spencer, Richard P.; Lange, Robert C.; Treves, Salvador (Yale Univ., New Haven). J. Nucl. Med.; 12: 216-21 (May 1971).

The possible usefulness of ^{135m}Ba and ^{131}Ba as agents for bone scanning was investigated in dogs and mice. Preliminary results showed that both ^{131}Ba and ^{135m}Ba have significant advantages over ^{85}Sr. (C.H.)

37839 LIVER SCINTIGRAMS COMPARED WITH ALKALINE PHOSPHATASE AND BSP DETERMINATIONS IN THE DETECTION OF METASTATIC CARCINOMA. Jhingran, Satish G.; Jordan, Leon; Jahns, Monroe F.; Haynie, Thomas P. (Univ. of Texas, Houston). J. Nucl. Med.; 12: 227-30(May 1971).

Because it provides anatomical information, the liver scintigram is superior to the alkaline phosphatase (AP) and bromsulphalein (BSP) tests in the detection of metastatic liver disease. The advantages of the scintigram are a lower percentage of false-positive results and a higher correlation with the extent of involvement than is true for tests of liver function. While they are as sensitive as the scintigram in detecting disease, AP and BSP retention studies produced a higher percentage of abnormality in patients with no anatomical evidence of liver disease. These false-positive results may be related to systemic effects of cancer elsewhere in the body or to toxicity from therapeutic measures used in these patients. A comparison of scan results alone and in combination with liver function tests suggested that the scan was as accurate in detecting hepatic involvement by metastasis as was a combination of tests. The scan was the most reliable test in predicting the extent of liver involvement. As such, it is the best of the three tests for estimating the degree of improvement or progression of metastatic lesions under therapy. (auth)

37840 ^{125}I-OIL RED O: CHROMATOGRAPHY, RADIOPURITY, AND LIPID BINDING. Pena, Hugo G.; Watts, Richard S. (Veterans Administration Hospital, Albuquerque, N. Mex. Univ. of New Mexico, Albuquerque). J. Nucl. Med.; 12: 245-8(May 1971).

The fractionation of commercial Sudan orange (a synthetic coal tar derivative used as a fat in stain) by chromatography is described, and an ^{125}I-tagged chloroform-methanol extract was identified as oil red O. The use of ^{125}I-oil red O for in vitro and in vivo diagnostic lipid metabolic studies is proposed. (auth)

37841 RAPID DOUBLE-ISOTOPE DILUTION DERIVATIVE ASSAY OF PLASMA TESTOSTERONE. Sparagana, M. (Veterans Administration Hospital, Hines, Ill. Loyola Univ., Maywood, Ill.). J. Nucl. Med.; 12: 253-6(May 1971).

A double-isotope dilution derivation technique for plasma testosterone is described. Use of thin-layer and gas chromatographic purification simplifies and hastens analysis approaching that of competitive protein-binding techniques. Carbon-14-T (58 mCi/mM) is used as marker steroid and ^{3}H-acetic anhydride (100 mCi/mM) as deriving reagent for mass measurements. Addition of testosterone acetate carrier after acetylation assists in recovery during purification which is achieved by several thin-layer separations and a final gas chromatography step. Testosterone acetate in the gas chromatographic effluent is collected, and the ^{3}H and ^{14}C present is counted in a liquid scintillation spectrometer set for double-label counting. Mass of testosterone is calculated from the double-isotope dilution derivative equation. (auth)

37842 ELECTRONIC MARKING DEVICE FOR A GAMMA SCINTILLATION CAMERA. Walton, P. W.; Sharpe, A. R. Jr. (Medical Coll. of Virginia, Richmond). J. Nucl. Med.; 12: 257-61(May 1971).

A device is described that allows the operator of a gamma

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camera to accurately transfer anatomical landmarks onto the radionuclide image. The marking procedure is simple in that only one switch has to be set on the control unit whereupon each mark appears when a microswitch on the collimator is depressed. Two optical pointer systems are used to locate the landmark: one is permanently attached to the pinhole collimator and the other one quickly attaches onto any of the parallel- or diverging-hole collimators. Bright point marks appear superimposed on, and cause minimal interference with, the radionuclide image. (auth)

37843 LOCALIZATION OF ^{87m}Sr IN EXTRA-OSSEOUS TUMORS. Papavasiliou, C.; Kostamis, P.; Angelakis, P.; Constantinides, C. (Univ. of Athens). J. Nucl. Med.; 12: 265-8 (May 1971).

Extra-osseous tumors of various histological types were visualized by ^{87m}Sr scintigraphy in six patients. There was no radiographic evidence of bone disease in any of the patients. (C.H.)

37844 CLINICAL COMPARISON OF TWO ^{99m}Tc TRACERS FOR BRAIN SCANNING: PERTECHNETATE VS. LABELED ALBUMIN. Schall, Gerald L.; Zeiger, Louis S.; Di Chiro, Giovanni; Briner, William H.; Matsen, Frederick (National Institutes of Health, Bethesda, Md.). Radiology; 99: 361-8(May 1971).

^{99m}Tc-pertechnetate (TcO) and ^{99m}Tc-albumin (TcA) were injected at different times into 60 patients for radionuclide brain studies. Twelve out of 20 lesions were demonstrated with TcO and 15 out of 20 with TcA. There were three false positives with TcA. Of the 42 studies interpreted as normal with both agents, 27 were equal in quality; in 15 the TcA study was more difficult to interpret because of the confusing concentrations of the tracer in certain vascular structures. TcO remains the agent of choice for routine screening work. (auth)

37845 FALSE NEGATIVE BRAIN SCANS EXCLUDING THOSE FOUND IN CEREBRAL INFARCTION. Shaw, R. A.; Du Sault, L. A.; Wilner, H. I. (Henry Ford Hospital, Detroit). Radiology; 99: 369-73(May 1971).

There were 45 false negative brain scans among 3,600 consecutive scans. Eleven of these cases were of cerebral infraction. Other intracranial disease was diagnosed in 34 on, or shortly after, the date of the false negative scan, and no explanation can be offered for 18 of these false negatives. Explanations suggested for the remaining 16 cases include head position during scanning, location of the lesion, repair of the damaged blood-brain barrier, and diffuse character of the disease. (auth)

37846 SITE OF ACCUMULATION OF ^{99m}Tc-SODIUM PERTECHNETATE IN BRAIN TUMORS. Sheldon, Baum (New York Medical Coll., N. Y.). Radiology; 99: 153-5(Apr 1971).

The site of accumulation of ^{99m}Tc-sodium pertechnetate in brain tumors was investigated using autoradiography. Autoradiographs of a mouse glioma showed that radioactivity was present exclusively in the tumor cells, with no evidence of radioactive material in the small blood vessels or intercellular spaces. Initial human studies have shown a similar accumulation of radioactivity in brain tumor cells. Brain tumors are probably visualized on ^{99m}Tc-sodium pertechnetate scans because of the presence of the radioactive material in the brain tumor cells. (auth)

37847 DIAGNOSIS OF METASTATIC TUMOR IN BONE USING THE DIGITAL MULTICRYSTAL CAMERA. Johnson, Philip M.; Reilly, James A. (Columbia Univ., New York). Radiology; 99: 125-33(Apr 1971).

Skeletal metastases can be detected with the multicrystal scintillation camera after administration of ^{85}Sr nitrate, 100 μCi, or Na^{18}F, 1000 μCi. Tracer levels in bone are quantified by the digital recording system of the camera. The most sensitive method of data analysis is measurement of the highest net count per two hundred seconds. Normal values of this parameter are presented for ^{85}Sr measured in 26 subjects without skeletal metastases. Two alternative methods, quantitative color scintiphotography and the 200-second accumulation interval, are less sensitive indicators of abnormal tracer concentration. (auth)

37848 FLUORESCENT THYROID SCANNING: SCANNING WITHOUT RADIOISOTOPES. INITITAL CLINICAL RESULTS. Hoffer, Paul B.; Gottschalk, Alexander (Univ. of Chicago. Argonne Cancer Research Hospital, Chicago). Radiology; 99: 117-23(Apr 1971).

Fluorescent thyroid scanning is a new technique of imaging the thyroid gland without administering a radioisotope to the patient. A narrow beam of γ rays from an isotope source, such as ^{241}Am, is directed toward the thyroid gland and the characteristic x rays produced by the stable iodine within the gland are measured using a lithium-drifted silicon detector. The scan can be made with an extraordinarily low radiation dose (less than 15 mrads). In 76 patients studied by this method, the thyroid scans obtained were comparable to isotope scans, and the information obtained regarding the iodine content of the thyroid gland was helpful in establishing the diagnosis of hypothyroidism and the presence of toxic thyroid nodules. (auth)

37849 ^{99m}Tc–SULFUR COLLOID LOSSES IN A DISPOSABLE SYRINGE. Freedman, Gerald S. (Yale Univ., New Haven). Radiology; 99: 197-8(Apr 1971).

^{99m}Tc–sulfur colloid becomes actively deposited in the rubber plunger of a disposable syringe as a function of time. Increased delay before injection will result in a lower dose to the patient. (auth)

37850 SCINTIGRAPHIC DETECTION OF PULMONARY BACTERIAL INFECTIONS WITH LABELED THYROID HORMONES AND PERTECHNETATE. Adelberg, Helen M.; Siemsen, Jan K.; Jung, Ralph C.; Nicoloff, John T. (Univ. of Southern California, Los Angeles). Radiology; 99: 141-6(Apr 1971).

In 14 of 16 patients, scintigraphic detection of acute pulmonary bacterial infections was observed utilizing ^{99m}Tc pertechnetate, ^{131}I-thyroxine, and ^{131}I-triiodothyronine. Failure to find some isotopic localization in patients with antibiotically-treated pulmonary bacterial or old tuberculous infections and pulmonary carcinoma indicates that an active infection is a prerequisite for this condition. These isotopes appear to concentrate in leukocytes which are actively phagocytizing bacteria. (auth)

Radiotherapy

Refer also to abstracts 37766, 37810, 37894, and 38527.

37851 (A/CONF.49/P–91) RECENT ADVANCES IN RADIATION THERAPY. Suit, Herman D. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.). Sep 1971. 14p. (CONF-710901–51). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The past decade has been a period of extraordinary advance in the entire field of radiation therapy. Important results are described following new methods of treatment for patients with Hodgkin's disease, carcinoma of the prostate, sarcomas of soft tissues located on extremities, sub-clinical metastases to regional lumph nodes, seminoma of testis, and combination of radiation therapy and surgery in the treatment of carcinoma of the urinary bladder (stage B^2 and C). Many technical advances have made a significant impact during this period. These include the wide availability of supervoltage equipment, computer calculated dosimetry, new dosimetry procedures, the combination of radiotherapy and chemotherapy, and after-loading techniques. Also of importance, has been the emergence of radiation therapy in the United States as a recognized medical specialty and research studies related to radiotherapy. Promising areas for investigation during the coming decade are also discussed. (auth)

37852 THYROID CRISIS INDUCED BY RADIOACTIVE IODINE. Shafer, Rex B.; Nuttall, Frank Q. (Veterans Administration Hospital, Minneapolis. Univ. of Minnesota, Minneapolis). J. Nucl. Med.; 12: 262-4(May 1971).

The appearance of acute thyroid crisis following administration of radioactive iodine has been well documented. With the changing modes of therapy, including pretreatment with antithyroid drugs, earlier recognition of thyrotoxicosis, and the effective early control of cardiovascular and metabolic manifestations by beta-adrenergic blocking agents, this clinical problem is becoming infrequent and more difficult to recognize. A report is presented of thyroid crisis following ^{131}I therapy of hyperthyroidism. (C.H.)

37853 MALIGNANT TUMORS OF THE NASOPHARYNX. Chen, Kuang Y.; Fletcher, Gilbert H. (Univ. of Texas, Houston. Radiology; 99: 165-71(Apr 1971).

Two hundred twenty-five malignant tumors of the nasopharynx treated by radiotherapy were analyzed with a detailed staging system for the primary tumor and neck nodes. Results indicate that: lymphoepithelioma patients have a better prognosis than do those with squamous-cell carcinoma; recurrences at the primary site and in the neck are less common in lymphoepithelioma than in squamous-cell carcinoma; retreatment of a recurrence at the primary site can be rewarding, particularly in lymphoepithelioma; additional radical neck dissection is not indicated unless there is evidence of active disease; and patients with unclassified tumors have a poor prognosis. (auth)

37854 COMBINED THERAPY IN BUCCAL MUCOSAL CANCERS. Krishnamurthi, S.; Shanta, V.; Sastri, D. V. L. N. (Cancer Inst., Madras). Radiology; 99: 409-15(May 1971).

A total of 927 cases of squamous-cell carcinoma of the buccal

mucosa were treated. The five-year results are analyzed in detail: after γ radiation alone to the primary tumor and the metastatic nodes; after combined radiotherapy and surgery; and with and without Synkavit sensitization. A preliminary evaluation was made of methotrexate. In 97% of the early cancers and in 35% of the late cancers, the primary lesion healed with irradiation alone. Postsurgical tissue-healing was not impaired as a result of initial radical irradiation in those cases in which a residue of the primary persisted. (auth)

Blast and Thermal Effects

37855 (ABCC-TR-7-69) AGE FACTOR IN RADIATION CARCINOGENESIS OF THE HUMAN THYROID. A STUDY OF 536 CASES OF THYROID CARCONOMA, HIROSHIMA-NAGASAKI. Sampson, Richard J.; Key, Charles R.; Buncher, C. Ralph; Iijima, Soichi (Atomic Bomb Casualty Commission, Nagasaki, Hiroshima (Japan)). 24 Apr 1969. 6p. Dep. NTIS.

In 3067 consecutive autopsies from the JNIH-ABCC Life Span Study in Hiroshima and Nagasaki 536 thyroid carcinomas (518 occult papillary) were found. Most of the prevalence is not related to radiation; the prevalence of thyroid carcinoma in the zero rad dose group is 16%. There is a significant excess prevalence in those exposed to 50 or more rad direct radiation at the time of the atomic bombs (ATB). Analysis by age indicates that in those 46 years or older ATB there is a significantly ($P < .02$) greater prevalence of thyroid carcinoma in those exposed to 50 or more rad than in those exposed to zero rad ATB. Those 20 years or younger showed a similar association but, presumably because of the small number of cases, the difference did not reach significance ($P < .14$) There was no indication that dose-prevalence relationships were different in the youngest and oldest age groups. The mean size of papillary carcinomas decreased in the females but not in the males with increasing age at death. This suggests that there may be age- and/or sex-related differences in factors promoting the growth of papillary carcinoma of the thyroid. (auth)

Radiation Effects on Animals

Refer also to abstracts 37730, 37734, 37735, and 37741.

37856 (A/CONF.49/P-93) MECHANISMS OF RADIATION INJURY AND REPAIR OF MOLECULES AND CELLS. Elkind, M. M. (Brookhaven National Lab., Upton, N. Y.); Painter, R. B. (California Univ., San Francisco. Lab. of Radiobiology). Sep 1971. 15p. (BNL-15776; CONF-710901-23). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Molecular lesions associated with sublethal radiation injury and, repair mechanisms are reviewed, with emphasis on mammalian cells. It is pointed out that radiation lesions and their repair often involve the genetic substance of cells and studies of forward and back reactions have led to insights into the normal processes of replication and segregation of DNA. Studies of damaged and repair mechanisms in mammalian cells, grown in culture, afford experimental ease and at the same time a relation to cells in humans not shared by microbes. Damage and repair mechanisms in bacteria are reviewed to erect a framework for results with mammalian cells. These concern ionizing and ultraviolet radiation and the processes of photoreactivation, repair replication, and recombination repair. Similar studies are discussed as they have been extended to mammalian cells. Repair expressible in terms of cell function is examined, namely, repair of sublethal injury after ionizing radiation, and the possible molecular lesions it may involve. Damage-repair processes can modulate the effectiveness of acute radiation exposures as in the radiotherapy of cancer. A repair process may be evident as a dose–effect relation which has a threshold. A threshold implies reduced effectiveness at low doses and low dose rates. Thus the self-stimulated repair of radiation damage may permit organisms to maintain normal function even while chronically exposed to low intensities of radiation. (auth)

37857 (ANL-7770, pp 76-100) BIOPHYSICS. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

Studies were conducted on basic properties of cultured mammalian cells, especially those relating to their growth and regulatory mechanisms. Basic studies on cell generation cycles included cell cycle compartment analysis of Chinese hamster cells in stationary phase cultures; synchrony by mitotic selection alone or with colcemid in Chinese hamster cells; and variation in sulfhydryl content of Chinese hamster cells during the cell cycle. Studies on radiation effects on cell division included effects of cycloheximide and x radiation on division delay in synchronized Chinese hamster cells; ultraviolet induced division delay in synchronized Chinese hamster cells; and effect of x rays on DNA, RNA and protein synthesis in synchronized Chinese hamster cells. Studies on effects of protective agents and sensitizers on Chinese hamster cells included sensitization of Chinese hamster cells to x rays by N-ethylmaleimide; recovery from sublethal damage induced by x irradiation in cysteamine protected Chinese hamster cells; and protective effects of thiols and thiophosphates against x irradiation in mammalian cells. Cytological studies included polyploidy induced by x rays in G_1 cells of Chinese hamster in vitro and effects of hydroxyurea on the chromosome repair process in x-irradiated cells. Magnetic resonance studies on biologically active molecules included assignment and conformational properties of the sugar-ring hydroxyl protons of the common nucleosides; a complete conformational model for uridine-5′-monophosphate in aqueous solution; complete analysis of the proton spectrum of uridylyl-(3′ → 5′) adenosine; analysis and conformational properties of actinomycin D; the hydration structure of collagen; development of a superconducting multinuclei nuclear magnetic resonance spectrometer system; and solvent dependence of the chemical shifts and coupling constants of 1,2-dichlorofluoroethylenes. Progress is also reported on the following; photobiology of circadian rhythms in protozoa and other eukaryotic microorganisms; testing the chronon theory of circadian timekeeping; molecular biology of circadian rhythms in eukaryotic cells; two classes of postirradiation oxygen effect in Staphylococcus aureus; and x-ray crystallographic study of a Bence-Jones protein; chemical studies of concanavalin A; an x-ray crystallographic study of the structure of concanavalin A; a chemical study of the carbohydrate binding sites of concanavalin A; and the primary structure of sucker hemoglobins. (H.L.W.)

37858 PYRIMIDINE DIMERS IN MAMMALIAN CELLS AND TISSUES (INDUCTION, PERSISTENCE, ROLE, AND REPAIR). Klimek, M. (Inst. of Biophysics, Brno). Stud. Biophys.; 19: 243-65(1970).

From fifth international ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

The effects of uv radiation on living cells were compared to ionizing radiation effects in terms of the molecular mechanism. The advantages of uv radiation are discussed with respect to specificity. Chemical components, such as pyrimidine and purine bases of nucleic acids and cyclic amino acids of proteins were analyzed for their uv radiosensitivity. The role of uv-induced pyrimidine dimers in blocking DNA synthesis in mammalian cells was also investigated. A mathematical model was used for determining the correlation between radiation dose, number of dimers induced, and DNA synthesis. (H.B.G.)

37859 RESTORATIVE EFFECT OF ADENINE ON FREE-DNA RELEASE FROM X-IRRADIATED RAT THYMOCYTES. Ohyama, Harumi (National Inst. of Radiological Sciences, Chiba, Japan). Int. J. Radiat. Biol.; 19: 177-81(1971).

Adenine added exogenously to rat thymocytes after 1 kR x-irradiation displayed a remarkable restorative effect on the release of 0.15 M NaCl-soluble DNA from the cells. Adenine also restored the adenosine terphosphate decline and cell-death, judged as erythrosin B inclusion of the 1 kR-irradiated thymocytes. A possible relationship among these phenomena was discussed. (auth) (UK)

Invertebrates

Refer also to abstracts 37711 and 37728.

37860 (ANL-7770, pp 100-1) CELLULAR FINE STRUCTURE AND RELATED FUNCTION. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

The grasshopper (Melanoplus differentialis) embryo during diapause was used to study the effects of x radiation on the ultrastructure of cells in a basal metabolic condition. Cytoplasmic myelination occurred and changes were observed in the nucleolus and ribosomes. The mitochondria remained undamaged. Studies were conducted on Paramecium as viewed from its constituent levels of organization. (H.L.W.)

37861 (RLO-2225-T-1-3) EFFECTS OF IONIZING RADIATION AND TEMPERATURE ON THE LARVAE OF THE PACIFIC OYSTER, CRASSOSTREA GIGAS. Nelson, Victor A. (Washington Univ., Seattle. Lab of Radiation Ecology). 10 May 1971. Contract AT(45-1)-2225-T1. 24p. (CONF-710501-10). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

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Chronic irradiation with ^{65}Zn and ^{3}H began either in the gamete, zygote, 2-cell, or rotating blastula stage of the Pacific oyster and continued until 48 hours after fertilization. The larvae were reared at 20, 24, and 28 C. In addition, experimental lots of zygotes were subjected to shock temperatures up to 46 C, but were reared at temperatures of 20, 24, and 28 C after the initial thermal shock. The criteria of effects were rate of development, frequency of abnormal larvae, and survival. The data were evaluated by analysis of variance methods. Statistically significant increases in the number of abnormal larvae were observed at ^{65}Zn and ^{3}H concentrations of 10^{-4} and 10^{-3} Ci per liter (approximately 1 rad), respectively, and at a dose of 10 roentgens from x-rays. No radiation effects were found on the rate of development or survival. Shock temperatures at which significant effects occurred were 36 C for the rate of development and for frequency of larval abnormalities and 32 C for survival. A rearing temperature of 28 C caused increased rate of development, increased abnormalities, and decreased survival. No interaction effects of ionizing radiation and temperature were observed in any of the experiments. (auth)

37862 RECOVERY STUDIES OF X-IRRADIATED TRIBOLIUM CASTANEUM (FLOUR BEETLE) LARVAE. Yang, Tracy C. H.; Ducoff, Howard S. (Argonne National Lab., Ill. Univ. of Illinois, Urbana). Radiat. Res.; 46: No. 2, 290-300(May 1971).

By means of the split-dose technique, a rapid recovery from a portion of radiation-induced damage was found in T. castaneum larvae. After irradiation at 30°C, recovery reached a maximum, or peak, at around 5 hours with a time to half-maximum recovery between 1 and 2 hours and dropped to a minimum around 8 hours. The rate of recovery, however, is strongly temperature-dependent. At low temperature (10°C), no peak could be detected within 8 hours. The arrest of recovery by low temperature is, nevertheless, reversible. In this study, although larvae showed a fast recovery from sublethal radiation damage, no complete or overrecovery was observed. From the slope of Arrhenius plot of the time of half-maximum of recovery vs reciprocal absolute temperature, the activation energy for the recovery of 14-day-old larvae was determined to be about 20.1 kcal/mole. The residual injury at 6 hours at 30°C was found to be proportional to the $^{7}/_{4}$ power of the conditioning dose. (auth)

Vertebrates

Refer also to abstracts 37733, 37740, 37745, 37759, 37760, 37809, 37831, and 37896.

37863 (ANL–7770) DIVISION OF BIOLOGICAL AND MEDICAL RESEARCH ANNUAL REPORT, 1970. (Argonne National Lab., Ill.). Dec 1970. Contract W-31-109-eng-38. 166p. Dep. NTIS.

Separate abstracts were prepared for 12 sections of the report. Additional sections are included on metabolism and toxicity of fission products and characterization of the ANL beagle. (H.L.W.)

For abstracts of individual sections see: 37403, 37711, 37729, 37760, 37857, 37860, 37864–37867, 37896, and 37899.

37864 (ANL–7770, pp 1-19) ACUTE AND CHRONIC EFFECTS OF EXTERNAL X-RAY AND GAMMA RADIATIONS. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

Cell proliferation of the hair follicle was studied using tritiated thymidine. It was found that the number of cells in the cycle increases for several days initially and a decrease in proliferation starts at about 15 days. The cell cycle time does not alter in the initial period of reduction in the number of proliferative cells at the end of the induced growth phase. For studies on the influence of route of administration on the uptake of tritiated thymidine, mice were injected intraperitoneally and intravenously; little difference was found between the routes of injection. New techniques were developed for explanting the three-day chick embryo for studies on radiation injuries to the microcirculation; for visualizing the peripheral microcirculation in the young chicken; and for freeze-fracture preparations of microvasculature and loose connective tissue. Studies on mechanisms of acute radiation damage and repair included in vivo observations of microvascular injury in the gamma-irradiated chicken; studies on ultrastructure of the chick mesentery and early effects of gamma radiation; an interpretation of the increase and decay of resistance to early lethal radiation injury; and long-term effects of ionizing radiations in the chicken. Studies were conducted on effects of hydroxyurea on cell-cycle kinetics of cultured antibody-forming cells and late effects of radiation on immune responsiveness of aging mice. Studies on laboratory animals included status of the colony, the development of inbred catalase mutant mice, and Rattus rattus as an experimental animal. Studies on diseases of laboratory animals included murine pneumonia; survival of Pseudomonas aeruginosa in acidified water; throat flora of a closed colony of beagle dogs; and identification of mites using the electron microscope. Studies on laboratory animal management included frequency of cage cleaning and the survival of mice; effects of acidified water on the health of mice; and long-distance air transport of aged laboratory mice. (H.L.W.)

37865 (ANL–7770, pp 26-47) NEUTRON AND GAMMA-RAY TOXICITY STUDIES. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

Modifications in the JANUS High Flux Exposure room are described with regard to the lead wall, shutter effectiveness, neutron activation, neutron spectrum, gamma spectra, kerma distributions, and irradiation planning. Studies were conducted on the effects of fission neutrons from the JANUS reactor, in comparison to x-ray effects, on Chinese hamster cells in culture; studies included asynchronous cell survival at various room locations and cell cycle variation and recovery in synchronous cells. Relative Biological Effectiveness studies on neutrons from the JANUS reactor included studies on survival of mice, colony-forming units, and intestinal microcolonies. Radiosensitivity of intestinal and bone marrow cells of mice was studied with regard to strain differences. Bone marrow cells from femurs of mice were obtained by aspiration or grinding the femur and it was found that radiosensitivity of colony forming units that survived either type of isolation trauma was similar. It was also found that estimates of colony forming units were influenced by recent immunization of mice with vaccinia virus. Hematopoietic injury and recovery were evaluated in mice by granulocyte mobilization. Studies were continued on analysis of survival and cause of death statistics for mice under duration-of-life gamma irradiation. Studies on long-term irradiated survivors and aged mice showed that the colony-forming unit content in femurs and/or spleen was lower in neutron- or x-irradiated survivors than in aged unirradiated animals. Studies on bacteriology of gamma irradiated mice showed that infection with Pseudomonas aeruginosa caused a decrease in the $LD_{50/30}$. (H.L.W.)

37866 (ANL–7770, pp 48-54) MECHANISMS OF CARCINOGENESIS. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

Derivatives of croton oil, phorbol esters A and C, were applied to the skin of mice that had been treated with 5000 rads of beta radiation. An increase in the incidence of both sarcomas and skin carcinomas was found. Other experiments on carcinogenesis were conducted by injecting polymeric ^{239}Pu subcutaneously in the anterior abdominal wall of intact and castrated rats. Results showed that there was no difference in tumor incidence between the two groups of rats. Studies were conducted on retention of ^{90}Sr and ^{90}Y in soft tissues of mice following intraperitoneal injection, and studies were continued on plasma and sperm concentrations of ^{85}Sr in dogs. The incidence of hepatomas was determined in rats fed a diet containing acetylaminofluorene; subsequent exposure to phenobarbital increased the incidence of hepatomas. Studies were continued on dietary and hormonal interplay in the regulation of rat liver ornithine aminotransferase; the regulatory effects of glucocorticoids were demonstrated. Studies on the functional properties of the ornithine aminotransferase molecule were continued. The counting efficiency of ^{32}P, ^{33}P, and ^{3}H was determined by Cherenkov counting and liquid scintillation counting with organic fluors. The uptake of lipids by nuclei of liver cells was studied by oral administration of tritium-labeled palmitic acid to animals; twenty-four hours later the tritium activity in the isolated nuclei was still present in the lipid. Studies were continued on experimental modification of structures at the periphery of the liver cell nucleus. (H.L.W.)

37867 (ANL–7770, pp 130-48) STUDIES OF RADIATION-INDUCED CHANGES. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

Studies on protracted exposure of beagles to ^{60}Co γ rays at 5 to 35 R/day included effects on survival and clinical observations; estimation of the LD_{50} at 35 R/day; pathologic changes in dogs exposed at 10 R/day; bone marrow cell ultrastructure in dogs continuously exposed to ^{60}Co γ rays; and beta-hemolytic streptococci in the throats of beagles receiving continuous ^{60}Co γ radiation. Studies were continued on the effects of x radiation on the thyroid gland of beagles fed a restricted iodide diet and thyroid response to protracted whole-body exposure to ^{60}Co γ rays. Progress is reported on the following: radiation dosimetry in beagles given intravenous doses of ^{137}Cs; inbreeding, ancestry, and radiosensitivity of beagles; comparison of hematologic effects in beagles given ^{137}Cs, ^{144}Ce, or exposed to ^{60}Co; source of beta-hemolytic strepto-

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cocci in beagle pups; clinical chemistry of the normal beagle dog; analysis of heritable influence on mean erythrocyte volume in beagles; and history of a beagle colony. (H.L.W.)

37868 (BNWL-SA-3874) EFFECTS OF ACUTE RADIATION IN CAPTIVE AND FREE-RANGING POCKET MICE, PEROGNATHUS PARVUS. O'Farrell, Thomas P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1970]. Contract AT(45-1)-1830. 18p. (CONF-710501-11). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

There was no significant difference between the responses of captive and free-ranging Great Basin pocket mice, Perognathus parvus, to acute ionizing radiation. The $LD_{50/30}$ values were 858 ± 27 rad and 834 ± 32 rad respectively, and slopes of both survival curves were parallel. (auth)

37869 (COO-1602-16) EFFECTS OF IONIZING RADIATION ON ENDOCRINE CELLS. VII. ANDROGEN SYNTHESIS AND METAOLISM BY RAT TESTICULAR MINCED AND TEASED-TUBULAR PREPARATIONS AFTER 450 r OF WHOLE-BODY X-IRRADIATION. Ellis, LeGrande C. (Utah State Univ., Logan); Van Kampen, R. (Utah Univ., Salt Lake City). [1970]. 41p. Dep. NTIS.

Male rats (Holtzman strain) were x irradiated when 12 weeks of age and sacrificed at 3-day intervals. Minced preparations of testicular tissue from irradiated and control rats were incubated with ^{3}H-pregnenolone and ^{14}C-progesterone and androgen synthesis was studied. Minced preparations were also incubated with ^{14}C-testosterone to measure rates of inactivation of this androgen. Teased-tubular preparations from both groups of animals were incubated with ^{3}H-pregnenolone and ^{14}C-progesterone. Short-term cyclic variations were seen in androgen synthesis by both the minced and the teased-tubular preparations used for control as well as irradiated animals. An increase in androgen synthesis on the first day corresponded with previously reported decreases in melatonin synthesis by pineal glands. Testosterone synthesis in tissues from irradiated rats was diminished after the first day in both the minced and teased-tubular preparations. Cyclic changes in testosterone synthesis with time were observed for both the control and irradiated animals, but the irradiated animals failed to respond quantitatively to the cyclic increase in androgen synthesis when compared with the control animals. Testosterone inactivation was increased by irradiation, but less androstenedione was formed from testosterone after irradiation. (auth)

37870 (COO-1602-23) EFFECTS OF X-IRRADIATION ON STEROID BIOTRANSFORMATIONS BY TESTICULAR TISSUE. Technical Progress Report. Ellis, LeGrande C. (Utah State Univ., Logan. Dept. of Zoology). 29 Apr 1971. Contract AT-(11-1)-1602. 10p. Dep. NTIS.

A brief summary is presented of studies on the effects of various doses of x radiation on the synthesis of steroid hormones in testicular tissues of rabbits and rats. A list of publications that report the results of the studies is included. (C.H.)

37871 (COO-2000-72) LOW-LEVEL X IRRADIATION OF THE BRAIN DURING DEVELOPMENT: MORPHOLOGICAL, PHYSIOLOGICAL, AND BEHAVIORAL CONSEQUENCES. Annual Progress Report, September 1, 1970-August 31, 1971. Altman, Joseph (Purdue Univ., Lafayette, Ind. Dept. of Biological Sciences). Contract AT(11-1)-2000. 17p. Dep. NTIS.

In 10, 30 and 90 day old rats we examined the morphological consequences of focal irradiation of the cerebellum during infancy with successive daily doses of low-level x-ray ($1-10 \times 200$ R from birth onward). In animals exposed to $1-2 \times 200$ R the subtotally eliminated external granular layer was reconstituted by 10 days and there was little or no reduction in the total area of the cerebellar cortex and its various layers at 30 and 90 days. With higher number of successive daily doses there was decreasingly less regeneration of the external granular layer at 10 days, and there was a proportional reduction in the areas occupied by the molecular and internal granular layers at 30 and 90 days. The skulls of 9-day old rats were irradiated with 100 R x-ray and they were allowed to survive for varying intervals, ranging from 10 minutes to 24 hours. Mitotic activity, cell pyknosis and phagocytosis were examined in the external granular layer of the cerebellar cortex with light and electron microscopy. Mitotic activity was reduced within 1 hour after irradiation, ceased altogether by the 3rd hour, and was resumed again by the 6th hour. Cell pyknosis became first evident morphologically by the 3rd hour. Groups of rats were injected with thymidine-^{3}H on 2 or 4 successive days between birth and 19 days of age covering the entire time span of postnatal neurogenesis. At maturity the concentration of cells that had their last mitosis soon after the injections (intensely-labeled cells) were counted in different layers and sublayers of the cerebellar cortex in order to determine the time of origin of the different microneurons. The following sequence was indicated: low granule cells → basket cells → low and high granule cells → stellate cells → high granule cells. The cerebellum of rats was irradiated daily with 150 R x-ray from birth for 2, 4, 6, 8 and 10 days. This led to a proportional decrease in the mature weight of the cerebellum due to interference with the acquisition of cerebellar microneurons. The motor development of these animals was observed from 11 to 30 days in an open field situation. It was also assessed in tests in which they had either to climb up on a rod or descend on a rope. The distribution of coated vesicles was examined by electron microscopy in the cerebellar cortex of rats aged 0, 3, 5, 7, 10, 12, 15, 21 and 30 days. Coated vesicles with a honeycomb-like external covering were identified in closed (spherical) and open (flask-like) forms. Closed coated vesicles were seen in large numbers in the vicinity of the Golgi apparatus, and sometimes in direct continuity with its cisterns, in rapidly growing regions of immature neurons, such as the apical cones of Purkinje cells in 3-7 day old animals, and in the dendrites of Purkinje cells in the 10-15 day old animals. (H.L.W.)

37872 (COO-2000-73) LOW-LEVEL X IRRADIATION OF THE BRAIN DURING DEVELOPMENT: MORPHOLOGICAL, PHYSIOLOGICAL, AND BEHAVIORAL CONSEQUENCES. Comprehensive Report, June 15, 1962-August 31, 1971. Altman, Joseph (Purdue Univ., Lafayette, Ind. Dept. of Biological Sciences). Contract AT(11-1)-2000. 15p. Dep. NTIS.

Studies on the effects of low-level x radiation on the cerebellar cortex during postnatal development included the following: a detailed ultrastructural study of the development of the cerebellar cortex under normal conditions; examination of histochemically processed cerebellar sections for the reconstruction of the chemical maturation of the normal cerebellum; an autoradiographic study of cell proliferation and migration with multiple injection of thymidine-^{3}H that covered the entire time span of postnatal cerebellar neurogenesis; a pilot study in which the cerebellum was irradiated at different periods and for different intervals; design and testing of devices that will make possible a more detailed and accurate analysis of postural and motor deficits produced by retardation of cerebellar development; ultrastructural and histochemical examination of cerebella irradiated with successive doses from birth onward; electrophysiological and pharmacological examination of cerebella with altered circuitries; and studies on replacing eliminated cells of the external granular layer by transplanting cells harvested from unirradiated animals. (H.L.W.)

37873 (DASA-2630) EFFECTS OF IRRADIATION AND BLAST ON PULMONARY FUNCTION IN SHEEP. Technical Progress Report. Yelverton, John T.; Damon, Edward G.; Jones, Robert K.; Chiffelle, Thomas L.; Luft, Ulrich C. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Jan 1971. Contract DA-49-146-XZ-359. 37p.

The changes in pulmonary function that result following unilateral exposure to LD_{50} doses of neutron-gamma irradiation and/or sublethal blast overpressures were investigated in sheep. Animals exposed to blast only and radiation plus blast demonstrated large increments in venous admixture ($\dot{Q}s/\dot{Q}$) on the day of insult followed by a major recovery toward baseline values during the first 24 hr following injury. The venous admixture of the blast only animals approached baseline 7 days after exposure but that of the radiation plus blast sheep did not return to baseline until 21 days. The sheep exposed to radiation only, blast only, and radiation plus blast sustained similar reductions in mean carbon monoxide diffusing capacity (DL_{CO}) which were below that of the control mean at 2 days and 7 days post exposure. All of the radiation only and radiation plus blast sheep that survived to or beyond 21 days displayed an overshoot or recovery to their individual baseline DL_{CO} values. The blast only and radiation plus blast animals also exhibited an increased mean ineffective alveolar ventilation (VA_{ineff}) which persisted from 1 to 14 days following the onset of trauma. The radiation only sheep had an increased VA_{ineff} from 2 through 7 days post exposure. (auth)

37874 (JPRS-53068) ROLE OF SYMPATHETIC NERVOUS SYSTEM IN CERTAIN REACTIONS OF THE VESTIBULAR ANALYZER TO IRRADIATION. Gezalyan, L. S. Translated from Biol. Zh. Arm.; 24: 50-7(Jan 1971). 9p. NTIS.

Rabbits were immobilized and subjected to rotation at an angular acceleration of 9°/second and angular velocities of 30, 60, 90, and 120°/second both clockwise and counterclockwise. The functional state of the vestibular apparatus was assessed by the duration of nystagmus recorded by means of needle electrode pickups inserted into the skull. The rabbits were divided into three groups: sym-

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pathectomized animals; those exposed to γ rays; and animals irradiated on the seventh day after sympathectomy. In the first group of animals there was a persistent decrease in excitability of the vestibular apparatus. Restoration of normal functioning usually occurred within two months after surgery. In the second group of animals a 300 R dose of γ radiation induced suppression of vestibulo-somatic reaction to adequate stimulation of the statokinetic labyrinth. The reactions were more marked than in the first group, particularly on the 5th to 10th day of radiation sickness. Total body irradiation of sympathectomized animals led to further inhibition of vestibular function. The decrease in excitability occurred following exposure to relatively small rotation velocities. Normal functioning was not restored two months after irradiation. It is concluded that changes in the functional state of the vestibular apparatus following irradiation may be related to changes in the influence of the sympathetic nervous system on this apparatus. (H.L.W.)

37875 (NYO–1800-36) INBORN ANEMIAS OF MICE. Progress Report, February 1, 1969–April 30, 1971. Russell, Elizabeth S.; Bernstein, Seldon E. (Jackson Lab., Bar Harbor, Maine). 1 May 1971. Contract AT(30-1)-1800. 21p. Dep. NTIS.

Genetically homogenous mice carrying anemia-producing genes were examined at all stages in the life history and the tissue-sites of primary gene action were studied in transplantation experiments. The lethal dose of x radiation for anemic mice was found to be much lower than for normal mice and strain variations in anemic mice were observed. The effects of spleen transplants or bone marrow injections from normal, anemic, or x-irradiated donors on the formation of erythroid spleen cell colonies and on the survival of normal, anemic, or x-irradiated recipient mice were studied. (C.H.)

37876 (NYO–3359-17) ALTERATION OF TASTE THRESHOLDS BY LOW DOSES OF IONIZING IRRADIATION. Seventh Year Progress Report, May 1, 1970–May 1, 1971. Shaber, Gary S. (Thomas Jefferson Univ., Philadelphia, Pa. Stein Research Center). Contract AT(30-1)-3359. 9p. Dep. NTIS.

The taste threshold for sucrose was determined in eight rats before and after 50 R of x-irradiation to the tongue. The pre-irradiation taste threshold value was .0015%. There was a more profound change in the sucrose taste threshold following irradiation than that seen for saccharin, which confirmed the suspicion that molecular size may play a role in the taste sensitivity change following tongue irradiation. (auth)

37877 (NYO–4175-1) EFFECTS OF RADIATION ON MIGRATORY ORIENTATION OF SALAMANDERS. Progress Report, February 1, 1970–April 15, 1971. Shoop, C. Robert (Rhode Island Univ., Kingston. Dept. of Zoology). Contract AT(30-1)-4175. 6p. Dep. NTIS.

Field studies were conducted on two species of competing salamanders in western Rhode Island. One species (Ambystoma maculatum) migrates from terrestrial retreats to vernal ponds in the early spring to breed and lay eggs, and returns to terrestrial retreats by early May. The other species (A. opacum) moves to the same pond basin in late summer after the water has evaporated to breed and deposit eggs in depressions under cover in the basin floor. The eggs of A. opacum may hatch when covered by water as the pond fills in late autumn or early winter. Both of these migrating species exhibit extreme precision in movements to and from the ponds. Radiation tolerance studies were carried out on amphibians utilizing a ^{137}Cs γ source. One hundred animals of each of the following species were irradiated at doses ranging from 20 to 3000 Rad: Ambystoma opacum; Rana pipiens; Rana sylvatica; Bufo terrestris; and Scaphiopus holbrooki. Preliminary results indicate that the Scaphiopus (spadefoot toads) is far more radioresistant than the other species. (C.H.)

37878 (ORO–2903-46) STUDIES IN THE USE OF IONIZING RADIATIONS AS STIMULI. Progress Report, June 1, 1970–May 31, 1971. Smith, James C. (Florida State Univ., Tallahassee. Dept. of Psychology). Contract AT(40-1)-2903. 9p. Dep. NTIS.

Progress is reported in studies of the visual perception of x radiation by rhesus monkeys, rats, and pigeons. Gamma irradiation was used as the unconditioned stimulus to condition rat's taste aversion to saccharin. (C.H.)

37879 (ORO–3564-15) TERMINAL REPORT, SEPTEMBER 1966–MARCH 1971. Dent, James (Virginia Univ., Charlottesville). Contract AT(40-1)-3564. 15p. Dep. NTIS.

Progress is reported on studies on the relation between the hypothalamus and pituitary function in amphibians. Data are reported from a study on the location of thyrotropic cells within the pars distalis of the newt (Triturus viridescens), the effects of temperature and stimulation of moulting on the survival of newts following thyroidectomy, the effect of hypothalamic extirpation on the release of injected ^{131}I from the thyroid gland of newts, and the effects of various doses of x radiation on regeneration of newt limbs following amputation. (C.H.)

37880 MITOTIC DELAY AFTER FRACTIONATED IRRADIATION OF C_3H MAMMARY TUMOR ISOTRANSPLANTS. Seydel, H. G.; Sloan, K. (American Oncologic Hospital, Philadelphia. Univ. of Maryland, Baltimore). Radiology; 99: 185-7(Apr 1971).

C_3H mice with spontaneous mammary tumors were subjected to a series of implantations followed by fractionated x irradiation. H & E-stained sections were obtained and mitotic counts were performed. These studies showed that the rate at which mitotic activity is resumed is indistinguishable from the control rate when the mitotic indices remain at control levels permanently. (auth)

37881 RECOVERY OF SHEEP AFTER WHOLE-BODY IRRADIATION: A COMPARISON OF CHANGES IN RADIOSENSITIVITY AFTER ACUTE OR PROTRACTED EXPOSURE. Page, N. P.; Ainsworth, E. J.; Taylor, J. F.; Leong, G. F. (Naval Radiological Defense Lab., San Francisco). Radiat. Res.; 46: No. 2, 301-16(May 1971).

The recovery pattern of sheep, i.e., the time-dependent changes in radiosensitivity (LD_{50}) to a high dose-rate challenge, was determined after a series of conditioning exposures of 165 or 305 R at dose rates ranging from 1.85 to 660 R/hr. Although there were certain quantitative differences related to dose rate and size of the conditioning exposure, the kinetics of recovery were basically the same for all conditioning regimens and consisted of three distinct phases. The first phase, in which recovery was slow, lasted 5 to 10 days. This was followed by a phase of rapid recovery and a transient period of radioresistance, exceeding the normal, at 15 to 20 days. In the third phase, beginning at 24 to 30 days and persisting at least as long as 75 days, the LD_{50} was slightly less than normal, representing either very slow recovery or irreparable injury. The mean survival times of decedents were routinely shorter when the challenging exposures were given during the first 20 days after conditioning than at later times. (auth)

37882 MARROW-DERIVED THYMUS PRECURSOR CELLS. AVAILABILITY AND POTENTIAL FOR RESEEDING BONE MARROW. Order, Stanley; Rawlins, Claudia (Harvard Univ., Boston). Radiology; 99: 177-83(Apr 1971).

The ability of bone marrow cells to repopulate the x-irradiated thymus of rats without delay is shown, and a quantitative assessment of thymus precursor cells in bone marrow is determined. By taking advantage of the sequence of cellular repopulation, a pool of large lymphocytes bearing donor antigen (early repopulation) and small thymic lymphocytes with tissue-specific antigen (late repopulation) were available for transfusion into secondary irradiated recipients. The large percursor lymphocytes with histocompatibility antigen could return to the marrow environment, whereas small lymphocytes, well-differentiated and bearing thymic antigen, were not capable of returning to the marrow environment. (auth)

37883 EFFECT OF DNA REPAIR INHIBITORS ON THE RESPONSE OF TUMORS TREATED WITH X-RAY AND ALKYLATING AGENTS. Gaudin, David; Yielding, K. L.; Stabler, Aubry; Brown, John (Univ. of Alabama, Birmingham). Proc. Soc. Exp. Biol. Med.; 137: No. 1, 202-6(May 1971).

Transplants of melanomas and plasmacytomas were given to hamsters 10 to 14 days prior to the start of the drug treatment. Following treatment with 800 R x radiation there was little decrease in the growth of tumors. However, administration of the inhibitors, caffeine or chloroquine, in conjunction with irradiation resulted in cessation of growth and in some cases regression in tumor size. Similar results were obtained using phenylalanine mustard. Experiments on the effects of Cytoxan in conjunction with chloroquine on the plasmacytomas resulted in complete cessation of growth followed by regression in tumor size. Mice were treated with Cytoxan alone or in combination with chloroquine; the white blood cell count decreased to a minimum three days following Cytoxan treatment and then returned to normal. Results demonstrate the ability of the DNA repair inhibitors to increase the sensitivity of tumor cells to alkylating agents and to x rays without having an apparent large increase in toxicity to hematopoietic tissue. (H.L.W.)

37884 INTESTINAL CELL KINETICS IN IRRADIATED MICE. A QUANTITATIVE INVESTIGATION OF THE ACUTE REACTION TO WHOLE BODY ROENTGEN IRRADIATION. Devik, Finn (Univ. of Oslo). Acta Radiol., Ther., Phys., Biol.; 10: 129-49 (1971).

Quantitative estimates were made of the number of epithelial cells, mitoses, dead cells and Paneth cells in the intestinal crypts of mice following increasing doses of whole body roentgen irradiation at intervals of up to seven days. The results are compatible with an exponential cell survival curve with a high extrapolation number. The crypt cell population may prove useful in investigating reactions of rapidly proliferating cell populations to various external influences. (auth) (Sweden)

37885 EFFECT OF PRENATAL γ-IRRADIATION ON POSTNATAL ENZYME DEVELOPMENT IN THE BEAGLE. Wagner, M. T. Jr.; Garner, R. J. (Colorado State Univ., Fort Collins). Radiat. Res.; 46: No. 2, 380-93(May 1971).

The effect has been examined of a single exposure to 250-R ^{60}Co γ-radiation of the beagle conceptus at either the early blastocyst or late embryo stage on the ontogenesis of glycerol phosphate dehydrogenase and glucose-1-phosphate uridyl transferase in liver and glucose-6-phosphatase in liver and kidney. The postnatal activity of all hepatic enzymes was depressed in irradiated animals but at times varying with the enzyme and the age at exposure. It is suggested that the phenomenon represents a latent effect of radiation which is not expressed until a demand is placed upon enzyme synthetic mechanisms. (auth)

37886 RADIATION STUDIES ON MICE OF A NATURALLY TUMOR-RESISTANT STRAIN (X/Gf). NUCLEOLAR MORPHOLOGY OF THYMIC LYMPHOCYTES DIFFERING IN RADIOSENSITIVITY. Potmesil, Milan; Goldfeder, Anna (New York Univ., N. Y.). Radiat. Res.; 46: No. 2, 394-408(May 1971).

The morphology of nucleoli in cells of the lymphocytic line was studied in thymuses of whole-body irradiated and nonirradiated X/Gf mice. Mature lymphocytes and prolymphocytes of control and irradiated thymuses possessed ring-shaped nucleoli, trabeculated nucleoli, or both types. Lymphoblasts possessed trabeculated nucleoli, dense nucleoli, or both types. Ring-shaped nucleoli were also occasionally present in lymphoblasts. The quantitative evaluation of lymphocytes in thymuses at different time intervals after irradiation showed that mature lymphocytes with ring-shaped nucleoli decreased to a greater extent than lymphocytes possessing trabeculated nucleoli. The dose-effect on thymuses 24 hours after irradiation revealed the existence of different classes of lymphocytes in respect to their radiosensitivity. The most radiosensitive were mature lymphocytes and prolymphocytes with ring-shaped nucleoli (D_{37}140 R) and lymphoblasts possessing ring-shaped nucleoli in addition to other types of nucleoli (D_{37}275 R). The radioresistant classes were comprised of mature lymphocytes and prolymphocytes with trabeculated nucleoli (D_{37}335 and 460 R), and of lymphoblasts with trabeculated nucleoli and with dense nucleoli (D_{37}400 and 500 R). Mature lymphocytes and prolymphocytes possessing both ring-shaped and trabeculated nucleoli constituted a non-homogeneous population with D_{37} ranging from 135 to 460 R. The results showed a relationship between the distribution of ribonucleoproteins in nucleoli as related to the extent of RNA synthesis, and radiosensitivity of thymic lymphocytes. (auth)

37887 DECREASES IN 40-Hz EEG ACTIVITY IN THE OLFACTORY BULB FOLLOWING γ-IRRADIATION OF THE CAT. Uzzell, Barbara P.; Sheer, Daniel E. (Univ. of Houston, Tex.). Radiat. Res.; 46: No. 2, 343-52(May 1971).

The 40-Hz EEG activity of the olfactory bulb during 3, 24, and 48 hours, and 7 to 8 days following acute γ-irradiation was investigated with three total-dose groups of mature cats that received either sham, 500-R whole-body (WB), or 2000 to 3000-R head only (HO) irradiation. EEG recordings of the olfactory bulb were taken from alert, unrestrained animals and subjected to spectrum analysis. Serotonin (5-HT) and norepinephrine (NE) content of olfactory structures were determined for the HO group. Two animals that received 800- and 1000-R total-doses showed no changes in the electrical activity of the olfactory bulb following irradiation. A 40-Hz loss observed in the olfactory bulb recording during 3- and 24-hour periods following irradiation was transitory in the 2000–3000-R HO group; whereas, the same loss observed in the 500-R WB group during the 7-day postirradiation period was not transitory. 5-HT content of olfactory tissue tended to increase and NE content tended to decrease slightly in the 2000 to 3000-R HO group during the 3-hour postirradiation period. The 40-Hz loss in the HO group was related to an imbalance in NE and 5-HT content and to the actions of elevated 5-HT on inhibitory synapses in the olfactory bulb. (auth)

37888 RADIORESISTANCE IN HAMSTERS DURING HYPOTHERMIC DEPRESSED METABOLISM INDUCED WITH HELIUM AND LOW TEMPERATURES. Musacchia, X. J.; Volkert, W. A.; Barr, R. E. (Univ. of Missouri, Columbia). Radiat. Res.; 46: No. 2, 353-61(May 1971).

Hypothermic and active (normothermic) golden and albino hamsters were given whole-body exposures to ionizing radiation with a ^{60}Co irradiator. Hypothermia to body temperature ca. 7°C was induced using a helox–cold technique (80% helium, 20% oxygen, and 0°C ambient temperature). The radiation doses ranged from 600 to 5000 rads. Increased radioresistance was evident in the metabolically depressed hypothermic hamsters. Over a range of exposures up to 2000 rads, hypothermic hamsters showed increased mean survival times. Percent survival data for each type of hamster gave respective $LD_{50(60)}$ values of 1067 ± 24 and 875 ± 15 for hypothermic and active golden hamsters, and 1143 ± 99 and 867 ± 34 for hypothermic and active albino hamsters. Dose-reduction factors were approximately 1.22 and 1.31. The increased radioresistance was examined in light of limited hypoxia and general metabolic depression. (auth)

Man

Refer also to abstracts 37766, 37794, 37807, 37852, and 37855.

37889 (A/CONF.49/P-82) EVALUATION OF LONG-TERM EFFECTS OF LOW LEVEL WHOLE BODY EXTERNAL RADIATION EXPOSURES. Storer, John B.; Bond, Victor P. (Oak Ridge National Lab., Tenn. Brookhaven National Lab., Upton, N. Y.). Sep 1971. 10p. (CONF-710901-19). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Late effects of exposure to high doses of ionizing radiation have been extensively studied in a number of human populations. These include patients treated with x rays for ankylosing spondylitis, tinea capitis, or enlarged thymus; survivors of the atomic bombings in Japan; patients treated with radioiodine for thyrotoxicosis; and radiologists and radiological technicians who were occupationally exposed. Nearly every suitable exposed group has been studied or is under continuing study. Particular attention has been paid to the induction of neoplastic disease although other effects such as changes in the mortality rate, ocular lens changes, and other pathologic effects were looked for in some of these populations. Since there is little prospect of detecting effects in human beings exposed to low doses delivered at low dose rates, extensive animal experimentation has been conducted under carefully defined conditions to try to assess effects of dose rate and the shape of the dose-response curves for various end points. Data from human and experimental animal studies are reviewed, and an attempt is made to assess the risk of low levels of exposure. (auth)

37890 (LA-4651) EYEBURN THRESHOLDS. Zinn, John; Hyer, Ronald C.; Forest, Charles A. (Los Alamos Scientific Lab., N. Mex.). Mar 1971. Contract W-7405-Eng-36. 9p. Dep. NTIS.

This report describes a series of calculations that relate to identification of minimum threshold conditions for production of retinal burns, such as may occur in the imaging of intense light sources; e.g., lasers and nuclear explosions. These calculations consider the combined effects of optical absorption and thermal conduction in the retinal tissue for image diameters ranging from 1 to 1000 microns. Threshold energy dose levels are computed, based on the assumption that a retinal burn is the result of a temporary temperature excursion of at least 20°C. The results are compared with laboratory measurements of eyeburn threshold levels in primates and rabbits. A set of computed safe retinal dosage curves is presented, based on the assumption that temperature excursions of 5°C or less are not harmful, (5°C being the expected maximum temperature rise produced in an image of the sun). (auth)

37891 (NP-18815) CHANGES IN COAGULATION BY IONIZING RADIATION. Monge, Rodolfo Humberto Garcia (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Medicina). 1967. 28p. (In Spanish). Dep. NTIS (U. S. Sales Only).

Thesis.

A bibliographic review was made of the most important and recent studies on the hemostasis system with emphasis on the most acceptable theories for this biological process. The experimental study was made on 15 patients with cervicouterine cancer in the clinical stages I, II, III, and IV, treated with ionizing radiation at doses of 10,000 to 12,000 R. The bleeding time, coagulation time, prothrombin time, platelet count, and thromboplastin activity were determined. Hepatic functional tests were also made. Except for two cases in which the thromboplastin activity was abnormal, the results were normal or negative. This defect was transitory and was attributed to the platelet function. (tr-auth)

37892 X-RAY-INDUCED TERATOGENESIS IN THE MOUSE AND ITS POSSIBLE SIGNIFICANCE TO MAN. Rugh, Roberts (Columbia Univ., New York). Contract AT(30-1)-274. Radiology: 99: 433-43(May 1971).

Comparison of x-radiation-induced congenital defects in mice and man indicates that rodent data may be extrapolated to man when embryologically comparable gestation ages are considered.

XUM

The majority of radiation-induced congenital anomalies relate to the nervous system. Irradiation of the human fetus during the first trimester could lead to gross anomalies, while irradiation during the second or third trimester may lead to subtle functional defects. The human embryo is highly radiosensitive and should be protected against any exposure if possible, particularly during the first six weeks after conception. No human threshold for radiation-induced congenital anomalies has been established. (auth)

37893 DOSE RESPONSE IN HUMAN AND EXPERIMENTAL RADIATION-INDUCED HEART DISEASE. APPLICATION OF THE NOMINAL STANDARD DOSE (NSD) CONCEPT. Stewart, J. Robert; Fajardo, Luis F. (Stanford Univ., Calif. Veterans Administration Hospital, Palo Alto, Calif.). Radiology: 99: 403-8(May 1971).

The application of the nominal standard dose (NSD) concept to radiation schedules in Hodgkin's disease and in breast carcinoma following mastectomy has proved useful in defining pericardial tolerance as 1,500 roentgen equivalent therapeutic units (rets) in large-volume treatments and 1,850 rets in small-volume treatments. The dose response curve for pericardial fibrosis is similar in shape for humans and rabbits. If the heart must be included, reirradiation to tumoricidal doses for recurrence of Hodgkin's disease in the thorax carries an exceedingly high risk of subsequent pericarditis or pancarditis. (auth)

37894 RADIATION-INDUCED PSEUDORECIDIVATION. Vaeth, Jerome W. (Mount Zion Hospital and Medical Center, San Francisco). Radiology; 99: 173-4(Apr 1971).

Pseudorecidivation or pseudocancer of the skin occurred in 4.2% of 119 cancers of the skin treated with radiation. The lesions are characteristic and self-limiting. Excision of the lesion is unwarranted and may contribute to radionecrosis and unnecessary scarring. The lesion regresses spontaneously without symptoms and does not recur. (auth)

37895 VISUAL SENSATIONS PRODUCED BY SINGLE FAST PARTICLES. Charman, W. N.; Dennis, J. A.; Fazio, G. G.; Jelley, J. V. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London); 230: 522-4(23 Apr 1971).

It is stated that little attention has been paid as to whether single fast particles can produce a sensation of light on infringing on the eye, but this has become of interest due to reports of the Apollo astronauts that they saw flashes of light whilst in translunar flight. It has been suggested that the flashes were caused by single cosmic ray nuclei that penetrated the cabin walls and entered the eye to cause the sensation of light either through the mechanism of Cherenkov radiation within the retina, or by some form of direct excitation. Experiments are described with 3 and 14 MeV neutrons to investigate the possibility of direct excitation effects. Four volunteers received a dose equivalent of about 100 m rem to the head. All external light was excluded from the experimental chamber and each person was dark-adapted for at least 30 mins. before exposure. With a flux of 2×10^4 3 MeV n/cm^2/sec no visual effects were reported, but with a frontal exposure to a flux of 2×10^4 14 MeV neutrons, flashes were reported, the nature of which is described. The particle energies used ruled out the possibility of Cherenkov radiation in the eye fluids and tissues, and direct retinal stimulation was indicated. The original neutrons could not have been directly responsible for the flashes, since their range suggested a flash rate far in excess of that observed. In the case of the astronauts it is speculated that the flashes might have been due to energetic ô-rays produced by cosmic ray nuclei of high atomic number passing through the eye. It is suggested that the use of single high energy particles might prove a useful additional probe for exploring the properties of the retinal receptors. (UK)

Radiation Effects on Plants

Refer also to abstracts 37745, 37755, 37757, 37761–37764, and 37863.

37896 (ANL–7770, pp 101-15) PLANT RADIOBIOLOGY. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

Investigations were continued on correlative determinants of RNA metabolism in the gamma-irradiated Coleus leaf. It was found that postrradiation supply of auxin to the petiole raised the activity of soluble ribonuclease and enhanced the rate of RNA synthesis. A capacitance auxanometer for the measurement of growth rates was developed. Progress is reported on the following: growth and constituents of oat plants grown under single and multidimensional gravity compensation; comparative morphology of normal and callus initiated carrot roots; plastid morphology and ontogeny in the oat seedling; participation of Golgi apparatus in geotropism; and kinetics and periodicity of auxin transport, geotropic curvature and growth. Studies on the physiological effects of environmental stress on plants included: the effect of gravity on the soluble carbohydrate economy of oat seedlings; quantitative extraction, separation, and measurement of fructose, glucose, and sucrose in plant tissue; the physical basis of gravity stimulus nullification by clinostat rotation; the removal of lead from air by soils; and rest period reduction in non-stored onion (Allium cepa) sets. Photobiology studies in mammals included: x radiation and the circadian thermoperiodicity of Perognathus penicillatus; spectral sensitivities for the phasing of circadian temperature rhythms in Perognathus penicillatus; and the induction of chromosome aberrations in pig kidney cells by far-red light. (H.L.W.)

37897 DETERMINATION OF IRRADIATION EFFECTS ON THE THYMIDINE KINASE ACTIVITIES WITHIN A CELL-CYCLIC OF SYNCHRONOUSLY GROWING CHLORELLA. Cabela, E.; Altmann, H. (Reaktorzentrum, Seibersdorf, Austria). Z. Naturforsch.; 26b: 149-51(Feb 1971). (In German).

Investigation on the thymidine kinase activities within a cell cycle of synchronously growing Chlorella cells showed a marked increase in the enzyme activity towards the end of the DNA replication. Immediately after γ irradiation with doses of 15 and 35 krad, no significant changes in activity were found; 3 hr after irradiation a remarkable decrease in the enzyme activity was observed. (auth)

37898 POSTRADIATION RESTORATION OF PRIMARY CYTOGENETIC INJURIES AND THE RADIORESISTANCE OF PLANTS. Valodzin, U. G.; Gardzei, I. A.; Gardzei, H. M. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 3, 73-9(1970). (In Belorussian).

Studies were made on the dynamics of changes in chromosome aberrations of a high heterosis corn hybrid Minskiy-1 and its original parent forms. The most intensive reduction in the number of cells with chromosome aberrations was observed at the end of the first mitotic cycle. This indicates the presence of more pronounced reparative processes. It is suggested that one reason for the increased radioresistance of heterosis hybrids is their capacity for more intensive restoration of cytogenetic damage. (JPRS)

Radiation Effects on Microorganisms

Refer also to abstracts 37765 and 37767.

37899 (ANL–7770, pp 118-30) MICROBIAL GENETICS. (Argonne National Lab., Ill.).

In Division of Biological and Medical Research annual report, 1970.

The distribution of cell generation times and its relationship to linear cell growth were investigated. The uptake of ^{42}K during the cell growth-duplication cycle was examined in both synchronized and synchronous cultures of Escherichia coli. In a synchronized culture, uptake rates were relatively constant during the first half of the initial cycle, doubled abruptly during the last half, and returned to the initial value when all cells had divided. There was no detectable deviation from a constant rate of uptake throughout the entire cycle in synchronous cultures. Studies were continued on chromosome replication in slowly growing cultures of Escherichia coli. Studies on regulation of chromosome replication in Bacillus subtilis included marker frequency analysis after amino acid starvation; effects of amino acid starvation in strain W23; and modulation control of DNA replication. Different scintillation cocktails were evaluated for the counting of tritiated RNA separated by sucrose gradient centrifugation. Progress is reported on the following studies: repair of damage induced by near uv and visible radiations in various strains of Escherichia coli; photoreactivation of 365 nm lethality in E. coli; the lethal effects of ^{125}I decay in E. coli and in bacteriophages; and changes in the mean cell volume of E. coli after bacteriophage infection. (H.L.W.)

37900 (ORO–3408-10) [PROGRESS REPORT ON PHYSICOCHEMICAL STUDIES OF RADIATION EFFECTS IN CELLS]. Powers, E. L. (Texas Univ., Austin. Lab. of Radiation Biology). May 1971. Contract AT(40-1)-3408. 11p. Dep. NTIS.

Studies were continued on water content, oxygen, and photoreversal of germicidal ultraviolet effects on spores. Studies on sensitivity of bacterial spores to heat and x radiation showed that when spores were irradiated in the wet anoxic state that maximizes survival after heat treatment, a biphasic survival curve was obtained. It was found that renaturation by fast cooling changes the conformation of the sensitive component only slightly as measured by radiosensitivity, whereas slow cooling results in two configura-

tions, neither of which resembles the original unheated spore geometry. X irradiation of spores at pH 3.8 to 10.4 without previous heating showed that spores that demonstrate the slow cool thermal effects after reversal show the biphasic kinetics observed in slow cooled spores irradiated directly. Studies on dose-rate effect include observations in an inert system; the effect seems to be purely photochemical and non-enzymatic, and the effect is different in monochromatic 254 light than it is in unfiltered germicidal light. In order to study the effect of chopped light, a Brower Chopper set for 60 Hz with 1:1 ratio for light and dark periods was used to irradiate spores in suspension. The survival curves obtained show inactivation constants that are represented by a graph. Proposals for continuation include studying the effects of water and oxygen in the ultraviolet effects, post-treatment reversions with near uv, the dose rate problem, and conformational changes and radiosensitivity. (H.L.W.)

37901 FOUNDATIONS OF ULTRAVIOLET EFFECTS. 5th International Ultraviolet Colloquium, Kuehlungsborn, Germany, October 19–22, 1969. Stud. Biophys.; 19: 1-268(1970). (In German and English). (CONF-691058).

Twenty-two papers are included; separate abstracts were prepared for 19. One of the articles not included in NSA contains information on photoreaction of 6-azacytosine and 6-azacytidine. The two remaining articles on uv-induced lethal sectorization in E. coli and yeasts and influence of 5-azacytidine on reversion and uv sensitivity of E. coli K-12-strains with different uvr-genes present abstracts only. (H.B.G.)

For abstracts of individual papers see: 37736–37738, 37767, 37768, 37858, and 37902–37914.

37902 ROLE OF RECOVERY IN RESISTANCE OF BACTERIAL CELL TO UV-LIGHT AND X-RAYS. Zhestyanikov, V. D. (Inst. of Cytology, Leningrad). Stud. Biophys.; 19: 61-101 (1970).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

Differences in cell resistance in one species to the injurious effect of uv-light and x irradiation of low density, which can be significant, are reviewed. These variations are accounted for by different abilities of cells in repairing radiation damage. There is a close correlation between the radioresistance and state of the excision repair system. In radioresistant strains this system is intact while in radiosensitive ones it is deficient at some steps. The inhibitors of dark repair sensibilize radioresistant strains of bacteria affecting insignificantly radiosensitive cells. Some variations in radioresistance do not correlate with the state of excision repair system. A greater radiosensitivity of filament-forming strains of E. coli under normal conditions after irradiation is associated with disturbances of cell division by irradiation. In this case the repair is accomplished in a different manner. The role of other reparatory processes (LHR in yeasts, post-replicative repair etc.) in resistance of the cell to irradiation is not quite clear. Most likely, the repair mechanisms are connected with the system providing the maintenance of stability of genetic structures without irradiation. They seem to be of primary importance for the normal viability of the cell and its response to some non-irradiation influence. 137 references. (auth)

37903 INFLUENCE OF CHEMICALS ON THE LETHAL AND MUTAGENIC EFFECTS OF UV-LIGHT ON THE EXTRACELLULAR BACTERIOPHAGE C_d. Kriviskii, A. S.; Tikhomirova, L. P. (Inst. for Molecular Biology, Moscow). Stud. Biophys.; 19: 103-21(1970). (In Russian).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

The influence of hydroxylamine (HA) and acridine orange (AO) pretreatment of extracellular virulent phage C_d E. coli CK, and the substitution of thymine by bromdeoxyuridine (BUdR) in phage DNA on the lethal and mutagenic effects of uv-light were investigated. The analysis of mutation curves obtained after combined action of HA and uv showed that under various conditions of an experiment the mutagenic effect is additive. This suggests that mechanisms of mutagenic action by both mutagens are similar and that the majority of uv-induced mutants of phage C_d arise as a result of cytosine residue lesions in the DNA but not as a result of thymine dimerisation. (auth)

37904 CULTIVATION OF BACTERIA WITH 8-AZAADENINE AND THE INFLUENCE ON THE UV-SENSITIVITY. Jacob, H.-E.; Kittler, L. (Institut fuer Mikrobiologie und Experimentelle Therapie, Jena, Ger.). Stud. Biophys.; 19: 123-9(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

Reported are results that were obtained with bacteria, grown in an 8-azaadenine containing synthetic medium. The Bacillus cereus strain is a wild type. The 8-azaadenine containing bacteria were more sensitive to uv light than the controls. This fact is in accordance with the in vitro studies of the uv stabilities of adenine and 8-azaadenine. With adenine-requiring strains of Proteus mirabilis no incorporation of 8-azaadenine was found and therefore no sensibilization took place. (auth)

37905 QUALITIES OF AN ESCHERICHIA COLI MUTANT WITH THERMOSENSITIVE DNA SYNTHESIS AND HOST CELL REACTIVATION OF UV-IRRADIATED λ PHAGES IN THIS MUTANT. Lanka, Erich; Mikolajczyk, Maria; Schuster, Heinz; Seehafer, Jutta. Stud. Biophys.; 19: 135-58(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

Escherichia coli mutants exist in which the capacity to synthesize DNA is thermosensitive. In one of these mutants (165/70) DNA synthesis and DNA repair were studied under a variety of conditions. At temperatures restrictive for DNA synthesis a limited breakdown of cellular DNA was observed. Degradation occurred only with the DNA most recently made at the permissive temperature. Thereby both strands of the DNA, synthesized as low molecular weight fragments, were affected. Replication of phage λ DNA was blocked in 165/70 at the restrictive temperature. However, in contrast to cellular DNA, the most recently made viral DNA was not degraded when the infected cells were shifted from the permissive to the non-permissive temperature. These findings might indicate that the DNA replication sites of cellular and λ DNA are different. Host cell reactivation of uv-irradiated phage λ in 165/70 could no longer be inhibited by caffeine when the infected cells were incubated for 20 to 30 minutes at non-permissive temperatures. Under these conditions the fate of uv-irradiated parental phage DNA was studied. (auth)

37906 HOST-CELL REACTIVATION OF UV- AND PHOTODYNAMICALLY INACTIVATED PHAGES. Geissler, Erhard (Univ., Rostock, Ger.). Stud. Biophys.; 19: 163-70(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

Coliphages treated photodynamically or with uv light were divided into four groups according to their sensitivity to host-cell reactivation. T_{even} phages were not host-cell reactivated. Temperate phages lambda and 434 however were host-cell reactivated either by excision repair or by gene controlled repair. UV treated T_{odd} phages were reactivated by excision repair only. Photodynamically inactivated T1 phages were host-cell reactivated by excision repair. T5 and T7 phages treated photodynamically were not sensitive to host-cell reactivation. (auth)

37907 SENSITIVITY OF RECOMBINATION DEFICIENT PHAGES TO UV LIGHT AND PHOTODYNAMIC TREATMENT. Geissler, Erhard (Univ., Rostock, Ger.). Stud. Biophys.; 19: 171-5(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

Lambda redB mutants that did not produce an active β protein were much more sensitive to photodynamic action sensitized by thiopyronine than redA mutants and wildtype phages. On the other hand, redA mutants that did not produce an active exonuclease were more sensitive to uv light than redB mutants and wildtype phages. Studying several T4 mutants it was found that wildtype phages as well as $T4v_1$ mutants and $T4v_1x$ double mutants were equally sensitive to photodynamic action, while T4x mutants that were recombination deficient were much more sensitive. They are believed to be inactivated additionally by an abortive repair process. (auth)

37908 X-IRRADIATION OF BACTERIOPHAGES T2r IN BUFFER T2: STUDIES OF A HOST CELL REACTIVATION. Tolkendorf, E. (Institut fuer Biophysik, Berlin). Stud. Biophys.; 19: 177-84(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

By x irradiation of bacteriophages T2r in buffer, survival curves of the two component types were received. The cause of this phenomenon was believed to be host cell reactivation. A possible host cell reactivation of the x irradiated phages T2r with hcr^- rec^-, and exr^- E. coli mutants was studied. Only the irradiated phages plated with the exr^- mutant showed a survival curve that was significantly steeper than the curve of the phages plated with wild type cells. It is believed that the cause for the smaller slope of the survival curve of the phages in E. coli B must be a host-cell reactivation. (auth)

37909 MECHANISM OF (UV) INDUCTION OF PROPHAGE. Geissler, Erhard (Univ., Rostock, Ger.). Stud. Biophys.; 19: 185-206(1970). (In German).

XUM

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

The mechanism for uv induction of prophages is discussed. It is assumed that interaction with either oligonucleotides during repair of DNA damage or release of single stranded DNA fragments during post replication repair are responsible for induction of prophages. This theory is compatible with the noninducibility of cells harboring an ind$^-$ prophage. Phage repressors are believed to be allosteric oligomers that are neutralized by reaction with an operator and a repair product. (H.B.G.)

37910 EFFECT OF SUPERINFECTION WITH λ-PHAGES ON THE LENGTH OF THE PHOTOREVERSIBLE PHASE OF UV IRRADIATED LYSOGENIC BACTERIA. Scherneck, S.; Theile, M.; Geissler, E. (Univ., Rostock, Ger.). Stud. Biophys.; 19: 207-14(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

UV irradiated lysogenic HCR$^+$ and HCR$^-$ cells are sensitive to photoreactivation for about 15 and 35 minutes, respectively. Then the photosensitivity is lost suddenly. By superinfection with λ_0-phages at various times after uv-irradiation the length of the photoreversible phase was shortened in dependence of the multiplicity of infection. Superinfection with λ-wild-type-phages and with 434hysusN7, respectively, was without effects on the length of the photoreversible phase. The results are discussed in terms of an induction-hypothesis. (auth)

37911 INDUCTION OF LYSOGENIC E. COLI K12 (λ) BACTERIA BY COMBINED TREATMENT WITH X-RAYS, UV LIGHT, AND MITOMYCIN C. Theile, M.; Scherneck, S.; Geissler, E. (Univ., Rostock, Ger.). Stud. Biophys.; 19: 215-26(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

Experiments are described to check the hypothesis on prophage induction, which is believed to be a consequence of production of single stranded DNA fragments during repair processes. The influence of a combined treatment of lysogenic cells differing in their hcr-state with x rays and mitomycin C or uv, respectively, was studied. Analogies are discussed between induction by uv and mitomycin C. Under the combined influence of x rays and uv irradiation the hcr$^+$ cells were induced to an extent corresponding to the sum of both single effects. In hcr$^+$ cells the inducing effect of the combined treatment with x rays and mitomycin C, however, was smaller than the sum of both single effects. This might be the consequence of some interference of x irradiation with the production of lesions by mitomycin C. In contrast, pre-irradiation of hcr$^-$ cells with x rays stimulated the inducing effect not only of uv light but also of mitomycin C very effectively. (auth)

37912 PROPHAGE INDUCTION BY U. V.-IRRADIATED TRANSFORMING DNA. Schlechte, H.; Geissler, E. (Univ., Rostock, Ger.). Stud. Biophys.; 19: 227-32(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

Bacillus subtilis 168 M (SP02) try$^-$ is a transformable bacterial strain that is truly lysogenic. The SPO2 prophage carried by this strain is inducible by uv light as well as by mitomycin C. The induction of SPO2 prophage by uv irradiated transforming Bacillus subtilis DNA is described. Lysogenic recipients treated with unirradiated DNA were transformed to a lesser degree than recipients that are not lysogenic. This might be the consequence of induction by degradation products of transforming DNA. It was not possible to demonstrate an increase of induced DNA treated lysogenic recipients. Using uv irradiated transforming DNA a twofold increase was observed in the titer of free phages from 2×10^6 to 4×10^6 depending on the applied dose. This effect was assumed to be the consequence of neutralization of phage repressors by degradation products of irradiated donor DNA. (auth)

37913 INTERPRETATION OF UV-INDUCTION CURVES OF LYSOGENIC BACTERIA IN TERMS OF THE CONTROL CHARACTERISTIC OF THE LAMBDA REPRESSOR. Noack, D.; Klaus, S. (Institut fuer Mikrobiologie und Experimentelle Therapie, Jena, Ger.). Stud. Biophys.; 19: 233-5(1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

The shape of sigmoidal surviving curves as a function of uv-irradiation is mostly interpreted as the result of a multi-target process. The stability of lysogenicity and the survival of lysogenic bacteria after uv irradiation were measured by the action of repressor molecules that repress transcription of most of the prophage genes. The inactivation of this repressor arose from the interaction with small molecular metabolites that were accumulated after uv irradiation because of inhibition of DNA-synthesis. It was found that the shape of dose survival curves for the colony-forming ability after uv irradiation is determined by the interaction of the phage repressor with small molecular metabolites. This interaction is discussed with respect to a model for the allosteric transition in macromolecular proteins. A mathematical method is described allowing the estimation of the number of subunits within an allosteric repressor molecule from experimental surviving curves. (auth)

37914 EXPERIMENTAL RESULTS SUGGESTING AN ALLOSTERIC NATURE OF THE LAMBDA-PHAGE REPRESSOR. Klaus, S.; Noack, D. (Institut fuer Mikrobiologie und Experimentelle Therapie, Jena, Ger.). Stud. Biophys.; 19: 237-41 (1970). (In German).

From fifth International ultraviolet conference; Kuehlungsborn, Germany (19 Oct 1969). See CONF-691058.

It is suggested that the λ repressor might be an allosteric protein that can be inactivated from operator binding by small molecular compounds arising from uv irradiation and other treatments resulting in the inhibition of DNA synthesis. In order to test this hypothesis a set of experiments was carried out using the cooperative action of heat and uv light on the inactivation kinetics of the thermosensible phage repressors due to a ts mutation in the A region of the C_I gene of the prophage. For interpretation of the experimental results it is postulated that the dose effect curve for the number of colony formers as a function of uv dose can be regarded as control characteristic of the phage repressor. The shape of these uv inactivation curves is affected by both the generation time of the continuously cultivated bacteria and heating. A relational model for the properties and the inactivation kinetics of the phage repressor after heating and uv irradiation is presented. It is suggested that the phage repressor active in operator binding can exist in two distinct conformations, an allosteric tetrameric and a non-allosteric monomeric one. The transition between these two conformations is postulated to be stimulated by means of both temperature and growth rate. In superinfection experiments using λc47 phage it was found that immunity is greatly increased after elevation of growth rate or of the induction temperature due to the postulated dissociation of the repressor tetramer. (auth)

37915 MECHANISM OF THE INHIBITION OF GERMINATION OF BACTERIAL SPORES BY γ IRRADIATION IN THE PRESENCE OF IODOACETAMIDE AND IODATE. Gould, G. W. (Unilever Research Lab., Bedford, Eng.). J. Gen. Microbiol.; 64: 301-9 (Dec 1970).

Whereas γ-radiation (·2 Mrad) alone either did not affect or stimulated spore germination, spores irradiated in the presence of iodoacetamide (IAM) or potassium iodate were inhibited from germinating in germinants like L-alanine, inosine or yeast glucose broth. Activity of a lytic enzyme which may be involved in germination was mostly lost in spores irradiated in IAM, and a phosphomonoesterase was about 60% inhibited. Spore alanine racemase was partly inactivated by γ-radiation alone but, with spore protease, survived irradiation in IAM without much further loss of activity. Although spores made non-germinable by γ-radiation plus IAM were nonviable as measured by colony counts, viability could be partly restored by chemical treatments known to by-pass the normal germination reactions. It was concluded that spores were inactivated by γ-radiation in the presence of the potentiators through inactivation of enzyme(s) essential in the degradative reactions of germination. The enzyme inactivation was caused by iodine-containing free radicals rather than directly by the γ-radiation. Spores used were Bacillus cereus, Bacillus coagulaus, Bacillus polymyoca and Bacillus subtilis. (auth) (UK)

Radiosterilization and Radiopreservation

37916 (ORO-680) EFFECTS OF LOW LEVEL IRRADIATION UPON THE PRESERVATION OF FOOD PRODUCTS. Final Summary Report, May 1963-March 1970. Dennison, R. A.; Ahmed, E. M. (Florida Univ., Gainesville. Dept. of Food Science). May 1971. Contract AT(40-1)-3097. 28p. Dep. NTIS.

A summary is presented of all work conducted under Contract AT(40-1)-3097 with the U. S. Atomic Energy Commission from May 1963 through February 1970 to determine the effect of low level irradiation upon certain food items prominent in the Florida agricultural economic system, with specific reference to citrus. The results are summarized of studies on the effects of irradiation on the decay control, peel injury, weight loss, firmness, color, flavor, composition, yield and quality of juice, respiration, and on the conduct of commercial-like shipping studies of citrus fruit.

Similar summary results are presented on the effects of low-dose irradiation on peaches, mangoes, and tomatoes. A summary of microbiological studies conducted on the effects of low-dose irradiation of Navel oranges and lemons inoculated with stem-end decay fungus is also presented. Similar studies are summarized for peaches inoculated with brown rot fungus. (auth)

37917 STORAGE LOSSES OF IRRADIATED VS CIPC TREATED RUSSET BURBANK POTATOES. **Sparks, Walter C.** Idaho Agricultural Experiment Station Bulletin No. 520, October 1970. Moscow, Idaho; University of Idaho (1970). 6p.

Studies were conducted to determine the effectiveness of treating potatoes with ionizing radiation as compared to treating potatoes with the chemical CIPC to prevent the sprouting and thereby extend the shelf life of the tubers. Results showed that the potatoes treated with radiation suffered a loss of 30% while those treated with CIPC had only a 20% loss. (P.B.M.)

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METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 37574.

Corrosion and Erosion

Refer also to abstract 39248.

37918 (ANL/ST-8) SODIUM TECHNOLOGY QUARTERLY REPORT, OCTOBER-DECEMBER 1970. Kesser, G. M. (comp. and ed.) (Argonne National Lab., Ill.). Mar 1971. Contract W-31-109-eng-38, 63p. Dep. NTIS.

The research, development, and management efforts during the period are reported. Work in the national meter program was continued on instrumentation for on-line monitoring of oxygen, carbon, and hydrogen impurities in sodium. Methods of detecting leaks in steam generators were studied to establish a commercial capability for on-line meters, which will be built to RDT standards. In the analytical standards program, the management effort involved formulation of interim standard analytical and sampling methods and the establishment of sample interchange programs to test these methods. Work continued on the development of a method for detecting fuel-cladding failures by monitoring the ^{135m}Xe daughter of ^{135}I. Studies of the chemistry of sodium included investigation of the nature of nitrogen-bearing species and elucidation of phase relations in the sodium-rich corner of the Na-O-H ternary system. Work on the purification of sodium continued with construction of an apparatus for characterizing the impurity content of cold-trapped sodium. Studies of materials-coolant compatibility included investigation of the transport of carbon in sodium-steel systems and development of methods for determining activities of nonmetallic impurities in sodium by equilibration of metal specimens. (auth)

37919 (IN-1477) DESTRUCTIVE EXAMINATION OF A HALLAM NUCLEAR POWER FACILITY INTERMEDIATE HEAT EXCHANGER. Random, W. L. (Idaho Nuclear Corp., Idaho Falls). Apr 1971. Contract AT(10-1)-1230. 52p. Dep. NTIS.

One Hallam Nuclear Power Facility (HNPF) intermediate heat exchanger (IHX) was disassembled and the components metallurgically examined by the Idaho Nuclear Corporation at Test Area North of the AEC National Reactor Testing Station, located near Idaho Falls, Idaho. The major objective of the examination was to provide data for assessment of crevice corrosion problems and evaluation of operational deterioriations associated with front-face type tube-to-tubesheet weld joints for sodium-to-sodium heat exchangers. Metallurgical evaluation of the front face tube-to-tubesheet welds found the welds to be structurally sound. The presence of sodium in the tube-to-tubesheet crevice did not damage the tubes or the tubesheet since no correlation was found between sodium deposits in the crevices and tube or tubesheet ligament cracks. The examination revealed stress corrosion cracking in some tubes and ligaments of the top tubesheet but not in the bottom tubesheet. (auth)

37920 (JUL-694-RW) CORROSION PROPERTIES OF STEEL IN STATIONARY MOLTEN LEAD. Ali Khan, I. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Sep 1970. 83p. (In German). Dep. NTIS (U. S. Sales Only).

The corrosion behavior of forty chromium and chromium-nickel steels in molten lead was investigated at 575, 650, and 750°C for a period of 3250 hr. The study shows that the corrosion of the Cr-Ni steel is not caused by the higher solubility of the Ni in the Pb, but by the intercrystalling corrosion attack with the precipitation of chromium carbide at the austenite grain boundaries. Since the chromium carbide is precipitated at lower temperature in increasing mass at the grain boundaries, higher corrosion attack was observed at 575°C. The steels with higher Ni content as X8CrNi12/12 and X5CrNiMo17/13 show up to 750°C lower corrosion attack than the corresponding 18/8 Cr-Ni steels. This is attributed to the increase of the solubility of the austenite in the Cr by increased Ni content of the steel. The non-stabilized and stabilized Cr-Ni steels with Mo additions in bend tests show stronger corrosion attack than the steels without Mo additions. This different corrosion attack was especially observable at higher temperature and can be attributed probably to the higher embrittlement tendency and a stronger sigma phase formation of the steels with Mo additions. Nb- and Ti-stabilized Cr-Ni steels with Mo additions are more susceptible to corrosion than the non-stabilized. The Nb- and Ti-stabilized 18/10 Cr-Ni steels in the bend tests show higher corrosion than the non-stabilized. In the Cr steels the pure ferritic steels have a good corrosion resistance. The X8Cr17 steel was not attacked by the molten lead up to 650°C. The Nb- and Ti-stabilized steels X8CrNb17 and X8CrTi17 show no corrosion at 575°C. The steels with perlitic texture were strongly attacked by the molten lead. The steels X45CrSi9, X55CrMo14, X90CrMoV18, and X7CrAl13 show stress crack corrosion. In the ferritic-austenitic Cr-Ni steels X4CrNiMoNb25/7 and X5CrNiTi26/15, a good corrosion resistance could be established at 575°C. The steel X4CrNiMoNb25/7 has almost no corrosion at 650°C. (tr-auth)

37921 (KFK-1301) LONG-TIME CORROSION INVESTIGATION OF AUSTENITIC Cr-Ni STEEL AND NICKEL-BASE ALLOYS IN SUPERHEATED STEAM (620°C, 1 ATM) WITH SPECIAL ATTENTION TO THE BEHAVIOR OF COLD-FORMED MATERIAL SURFACES. Leistikow, S.; Berg, H. v.; Pott, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Feb 1971. 73p. (In German). Dep. NTIS (U. S. Sales Only).

Seven superheat materials were tested in semidynamic steam loop experiments at 620°C and 1 atm during 5000 hours and in three different surface or bulk conditions. The experiments were evaluated by gravimetric measurements, chemical analysis of the steam condensate, and metallography. The experiment results verified the increased corrosion resistance of annealed nickel alloys and the effects of increasing oxidation rates on chromium depleted surfaces or coarse grain structures. Cold worked specimens of all alloys tested corroded uniformly and to an extent which was strongly diminished in the case of the CrNi steels. The high corrosion resistance which was built up by selective chromium diffusion and oxidation proved its long-time effectiveness through 10,000 hr of testing. (auth)

37922 (LMEC-70-21) EXAMINATION OF 2¼ Cr-1 Mo FERRITIC STEEL TUBES EXPOSED TO SMALL LEAKS OF WATER IN FLOWING SODIUM. Lee, W. T. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 1 Feb 1971. Contract AT(04-3)-700. 75p. Dep. NTIS.

Metallurgical examinations and evaluations were performed on a group of 52 2¼ Cr-1 Mo ferritic steel target tubes from Atomic Power Development Associates' Rig 10. These tubes were exposed to small leaks of water in 600°F flowing sodium. The extent of wastage was determined by dimensional and volumetric measurements. Metallographic, hardness, and scanning electron microscopic analyses indicate that the tube wastage process was controlled by (1) droplet impingement, and (2) temperature rise in the target tube caused by sodium-water reaction. A probable mechanism of wastage for the tubes is postulated. (auth)

37923 (RD/B/N-1721) INTERFACIAL PHENOMENA IN LIQUID METAL COOLED REACTOR SYSTEMS. Evans, H. E.; Watson, W. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1971. 27p. Dep. NTIS (U. S. Sales Only).

A survey is presented of the interfacial effects to affect mass transfer and other processes in liquid metal cooled fast reactors. Topics discussed include surface energy, wetting behavior, adsorption at liquid and solid surfaces and the development of contact potentials at interfaces between dissimilar materials. The relevance of these topics to mass transfer and other processes in a LMFBR under routine and fault conditions is discussed. (auth) (UK)

37924 (RD/B/N-1901) SOLUBILITY OF COPPER IN SODIUM. Evans, H. E.; Watson, W. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1971. 9p. Dep. NTIS (U. S. Sales Only).

A study of the solubility of copper in sodium using a recently developed neutron activation technique provided solubility values of S_{Cu} (ppM) of 3.7 at 385, 5.0 at 485, and 7.6 at 530°C. The reasons why these values differ from published values are discussed. Evidence for the reversible adsorption of copper on stainless steel is presented. (auth) (UK)

37925 THERMOCHEMISTRY OF LIQUID METAL-GAS CRUCIBLE REACTIONS IN VACUUM. Jansson, Sven A. (Westinghouse Research Labs., Pittsburgh). J. Vac. Sci. Technol.; 7: S5-13(Nov-Dec 1970).

From 2nd International Vacuum Metallurgy Conference, Anaheim, Calif. See CONF-700640.

Thermochemical analyses are performed for the Ti-O-C, Fe-O-C, Al-O-C, Si-O-C, Mg-O-C, Be-O-C, Y-O-C, Cr-O-C, and U-O-C systems at 1800°K. The role of hydrogen, water vapor, and nitrogen in connection with these systems is exemplified. Log $p_{Me_xO_y}$ vs log p_{O_2} and log p_C vs log p_{O_2} diagrams

are prepared to illustrate in a simple manner the relations between condensed phases and the equilibrium pressures of gaseous species over the different condensed phases. The diagrams are used to evaluate the correctness or applicability of available thermochemical data, and to predict or interpret reactions in or between the different systems, with particular reference to vacuum metallurgical processes. (auth)

37926 BEHAVIOR OF REFRACTORY METAL SURFACES IN ULTRAHIGH VACUUM AS OBSERVED BY LOW-ENERGY ELECTRON DIFFRACTION (LEED) AND AUGER ELECTRON SPECTROSCOPY. **Dooley III, George J.; Haas, T. W. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Vac. Sci. Technol.; 7: S90-100(Nov-Dec 1970).**

From 2nd International Vacuum Metallurgy Conference, Anaheim, Calif. See CONF-700640.

Surface phenomena of both refractory metal single crystals and polycrystalline foils in ultrahigh vacuum environments ($1 \times 10^{-9} - 2 \times 10^{-11}$ torr) are discussed. Some of the more common refractory metals which have been studied are Ti, V, Cr, Fe, Zr, Nb, Mo, Rh, Hf, Ta, W, Re, and Au. Surface studies are initiated once the sample has been placed in the ultrahigh vacuum chamber, and the entire system has been baked out for several hours around 250°C. The first technique employed is Auger electron spectroscopy which involves measuring the energies of certain inelastically (secondary) emitted electrons by means of modified low-energy electron diffraction (LEED) optics of a standard Varian unit. This technique enables the composition of the sample surface to be monitored during the cleaning procedures. Specifically, some of the cleaning procedures are high temperature anneals (to near the melting point), reaction with H or O, and Ar ion bombardment. Some of the various contaminants which segregate on several refractory metal surfaces during cleaning procedures are identified and techniques for their removal discussed. Once clean and in the $10^{-10} - 10^{-11}$ torr range, the surface of the sample will remain clean for extended periods of time. If the clean specimen is then exposed to somewhat higher pressures ($10^{-6} - 10^{-8}$ torr) of common gases such as O_2, H_2, N_2, and CO, the LEED pattern will in most instances change. One or more coverage states may exist for the same gas being chemisorbed onto the same single-crystal metal surface. In most cases, a new coverage state will give rise to a different LEED pattern. And, except for H, the particular adsorbed species can again be identified using Auger spectroscopy. Specific cases discussed are the adsorption of H, O, and CO on the three most densely packed planes of Mo, namely the (110), (100), and (112) planes, the adsorption of O on the Re (0001) plane, and other selected results on W, Ta, Hf, and Zr. (auth)

37927 GAS-METAL REACTIONS OF REFRACTORY METALS AT HIGH TEMPERATURE IN HIGH VACUUM. **Fromm, E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Vac. Sci. Technol.; 7: S100-5(Nov-Dec 1970).**

From 2nd International Vacuum Metallurgy Conference, Anaheim, Calif. See CONF-700640.

The reactions of Nb, Ta, Mo, and W with the gases H_2, N_2, O_2, H_2O, CH_4, and CO at high temperatures are discussed. Quantitative relations are compiled for the estimation of the minimum gas content attainable in vacuum metallurgical processes of both the degassing time and the metal loss due to oxide evaporation. (auth)

37928 OXIDATION OF BERYLLIUM-PLATINUM ALLOYS. **Latypova, I. M.; Volkova, R. M.; Matveeva, R. M. Fiz.-Khim. Mekh. Mater.; 6: No. 5, 28-30(1970). (In Russian).**

The kinetics of oxidation and the composition of oxide films of Pt alloys with Be additions were studied. The results obtained with Pt oxidation in air at 1300°C showed that the surface layer on the alloy consisted primarily of BeO. The oxidized film had good protective properties. (R.V.J.)

37929 INTERACTION OF OXYGEN WITH HOT TUNGSTEN FILAMENT: EFFECT OF THE WALL OF MEASURING CELL. **Hayashi, Nobuyuki; Watanabe, Jiro (Electrotechnical Lab., Tanashi, Japan). Shinku; 14: No. 3, 89-93(Mar 1971). (In Japanese).**

The interaction of oxygen with a hot tungsten filament was studied by the technique of isotopic mixing. The tungsten filament placed in the center of a spherical glass cell was flashed in isotopic oxygen $^{18}O_2$ of 10^{-6} torr. The cell wall was kept at several constant temperatures during the flashing. Isotopic carbon monoxide C ^{18}O observed at the initial stage rapidly diminishes within 30 min. At the next stage an increase of isotopic gases $C^{18}O_2$, $C^{18}OO$, $C^{18}O$ and CO is observed, but they begin to decrease after 60 to 90 min. Moreover, the evolution of these gases is decreased to a large extent by cooling the cell wall to lower temperature such as -72°C. It is concluded from these results that isotopic carbon monoxide and carbon dioxide are produced from the surface of the glass cell rather than caused by the interaction of oxygen with the hot tungsten surface with the exception of the initial stage. (auth) (Japan)

Preparation and Fabrication

Refer also to abstracts 37540, 37977, 38005, and 38302.

37930 (BM-RI-7521) NEW INTERNAL OXIDATION PROCESS FOR STRENGTHENING TUNGSTEN. **Blickensderfer, Robert; Copeland, Mark I.; O'Brien, William L. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Jun 1971. 40p.**

Tungsten alloys with high-temperature strength properties were produced by a new process called the oxyreaction process. The process involved additions of a powder of a reactive metal compound, ZrN, ZrW_2, or HfW_2, to a base metal powder, tungsten, which contained some oxygen. The powders were blended, compacted, sintered, and extruded. During sintering, diffusion and internal oxidation occurred to produce reactive-metal oxide particles and solid solutions. A dispersion of oxide particles could be precipitated by heat treating. The oxyreaction process circumvents many of the agglomerating and coarsening problems encountered in the current methods for dispersing a stable oxide in a metal. At a test temperature of 1,650°C, the alloys prepared from ZrW_2 had tensile strengths up to 70,000 psi and stress-rupture lives up to 142 hr at 10,000 psi stress; the alloys prepared from ZrN powders had tensile strengths up to 80,000 psi and stress-rupture lives up to 27 hr at 10,000 psi stress. Tensile strengthening in the alloys was attributed to Zr in solid solution or to Zr-O-W structures too small to be observed in an electron microscope replica. Stress-rupture life was attributed to a dispersion of submicron ZrO_2 particles which precipitated and grew to 0.05- to 0.2-micron size during the test. Tensile strengthening and stress-rupture life were dependent upon both the zirconium and oxygen contents with the maximum occurring at roughly 0.9 atomic pct Zr and 0.9 atomic pct 0. (auth)

37931 (CONF-710512-11) REPAIR OF PRIMARY PRESSURE SYSTEM PIPING IN A NUCLEAR POWER PLANT. **Norris, E. B.; Watson, P. D.; Wylie, R. D. (Southwest Research Inst., San Antonio, Tex.). 12 Feb 1971. 12p. (71-PVP-50). ASME, New York $2.00.**

From first national congress on pressure vessels and piping; San Francisco, Calif. (10 May 1971).

A leak found in a stainless steel "safe-end" attached to a feedwater nozzle in the LACBWR plant, led to a decision to replace all similar nonisolatable components. The selection of materials, removal and reinstallation operations, and quality control program are described. Problems which were foreseen, such as personnel exposure, and problems which arose during the operation also are discussed. (auth)

37932 CORROSION AND CORROSION PROTECTION. PART 9b. PRODUCTION METHODS FOR COATINGS AT THE CUSTOMARY AND THE LESS CUSTOMARY METALS. **Wiederholt, Wilhelm (Bundesanstalt fuer Materialpruefung, Berlin). VDI (Ver. Deut. Ing.) Z.; 113: 303-7(Mar 1971). (In German).**

Numerous methods are available for the manufacturing of metallic coatings on a metallic carrier material; it is feasible to apply each metal to the carrier material under consideration. Customary metals are, among others, coatings of tin, lead, copper, silver, gold, and coatings of platinum metals. The possibilities for the production of coatings consisting of less customary metals are compiled in a table. (auth)

37933 ENGINEERING STEEL PRESSURE VESSELS AND CONTAINMENTS. **Mueller, W. Sulzer Tech. Rev.; 52: 259-67 (1970).**

Sulzer possesses the equipment and the know-how for producing steel structures for nuclear power stations. The company can point to fabrications supplied for the Beznau and Mühleberg stations, as well as other similar work in the field of high-pressure vessels, penstock engineering and welded fabrications generally. The difficulties involved are due not to the quality requirements but to the unusual method of handling the contracts in accordance with American planning and control. The Mühleberg reactor vessel and the Mühleberg and Beznau safety vessels will be taken as examples illustrating the technical and organizational requirements entailed. In connection with the brittle fracture resistance of structures, attention is drawn to dangers inherent in thick-walled designs. The use of high-grade quenched and tempered steels and the fabrication of multishell vessels minimizes the risk of brittle fracture. (auth)

37934 VAPOR DEPOSITION BY LIQUID PHASE SPUTTERING. **Krutenat, R. C.; Gesick, W. R. (Pratt and Whitney Air-**

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craft, Middletown, Conn.). J. Vac. Sci. Technol.; 7: S40-4(Nov-Dec 1970).

From 2nd International Vacuum Metallurgy Conference, Anaheim, Calif. See CONF-700640.

Liquid binary alloy targets have been sputtered at ion densities of up to 100 W/cm^2 providing deposition rates in excess of 10 mils/hr in a combined sputtering–evaporation mode. At high power densities a self-sputtering mode has been demonstrated which allows deposition from 10^{-7} to 10^{-2} torr. Comparison of sputtered deposit compositions of Pb–24 In, Fe–30 V, and Fe–32 Ni with theoretical molar ratios predicted on the basis of thermal vaporization shows that alloy fractionation is substantially reduced. The composition of deposits from solid or liquid Pb–24 In targets had nearly the same Pb/In ratio, 5.8 (target ratio = 1.75) although the predicted ratio for thermalized vapor was 1300. For Fe–30 V liquid targets where less than 0.5% vanadium is predicted from thermal vaporization alone, a sputtered deposit containing 10.3% vanadium was found, suggesting that the approximate sputtering/evaporation ratio is 0.3. Liquid phase targets of Fe–32 Ni alloy had average molar ratios of Fe/Ni close to 3 (target ratio was 2.2), whereas the predicted ratio from thermal vaporization was 5.8. There was only a slight increase in Fe/Ni ratio in the self-sputtering mode at 10^{-6} torr over that obtained with argon sputtering at 10^{-3} torr. (auth)

37935 METALLURGICAL CHARACTERISTICS OF TITANIUM-ALLOY FOIL PREPARED BY ELECTRON-BEAM EVAPORATION. Smith, H. R. Jr.; Kennedy, K.; Boericke, F. S. (Air Reduction Co., Inc., Berkeley, Calif.). J. Vac. Sci. Technol.; 7: S48-51 (Nov-Dec 1970).

From 2nd International Vacuum Metallurgy Conference, Anaheim, Calif. See CONF-700640.

The supersonic titanium aircraft has requirements for high-strength titanium-alloy foil for honeycomb structures. In conventional rolling of such alloys as titanium–6% aluminum–4% vanadium, multiple high-vacuum anneals are required to reach the thin-foil gages, from 0.001–0.004 in., used for honeycomb cores. The advantages of electron-beam (EB) evaporation and deposition in the desired thicknesses, and without rolling and multiple vacuum annealing, are studied. The present research program is designed to prove that foils of such alloys, produced by EB evaporation on a moving substrate, are equivalent to the rolled products. EB foils easily meet the chemical and mechanical property requirements of aerospace specifications. Bend tests are superior to the rolled foil. The metallurgical characteristics have been evaluated using optical micrography and electron micrography with replica, transmission, and scanning techniques. The deposits are fully dense and of grain sizes from 0.2–0.8 μ. Microprobe analyses indicate that the chemical composition is uniform and contains alpha and beta phases. All metallurgical characteristics of EB evaporated foils appear to be suitable for the intended end uses. Evaluations in the form of actual honeycomb structures are underway. (auth)

37936 PURIFICATION OF VANADIUM BY VACUUM MELTING. Anable, W. E. (Bureau of Mines, Albany, Oreg.). J. Vac. Sci. Technol.; 7: S74-81(Nov-Dec 1970).

From 2nd International Vacuum Metallurgy Conference, Anaheim, Calif. See CONF-700640.

The purification of two commercially available vanadium samples by three vacuum melting techniques was compared: consumable-electrode arc melting in a conventional deep mold, consumable-electrode arc melting at the top of the mold, and conventional electron-beam melting. Top-of-the-mold (TOM) and electron-beam (EBF) melts were both conducted in the same vessel equipped with a bottom-withdrawal mechanism. Pressures during melting were in the range of 0.10–0.50 m torr; the pressure in the deep mold could not be measured, but probably exceeded 100–300 m torr during a typical melt. Arc melting was characterized by melting rates of 500–800 g/min, but electron-beam melts were limited to rates of 20–30 g/min. Forty-nine percent of the oxygen content was removed by double melting vanadium sponge at the top of the mold, and 42% of the oxygen content was removed from electrorefined vanadium treated in the same manner; however, the carbon and nitrogen increased. The purity of samples melted at the TOM approached the purity of samples prepared in the EBF. In some instances, a further decrease in the oxygen and metallic impurity content resulted from remelting selected materials in the electron-beam furnace. Little or no purification resulted from melting vanadium in the conventional deep mold. Purification proceeded faster and more completely on melting vanadium with small additions of yttrium, carbon, or aluminum; aluminum was largely removed on double melting, but carbon and yttrium were retained in the products. Metal or carbon additions tended to stabilize the arc and improve metal recovery from 85 to greater than 90% during a consumable-electrode arc melt. Typical metal hardness ranged from Rhn B-20 to B-30. Mass-spectrometric studies conducted in conjunction with the purification work demonstrated that CO, CO_2, Al_2O, and AlO were the principal oxides, while Al, Fe, Ti, Mn, Ni, V, Cr, Ca, and Cu were the principal metallics evolved when heating and melting vanadium. The volatilization of VO was slow and incomplete; therefore, sacrificial dissociation was of minor importance in the purification of vanadium. (auth)

37937 ELECTRON-BEAM FLOAT ZONE AND VACUUM PURIFICATION OF VANADIUM. Reed, R. E. (Oak Ridge National Lab., Tenn.). J. Vac. Sci. Technol.; 7: S105-12(Nov-Dec 1970).

From 2nd International Vacuum Metallurgy Conference, Anaheim, Calif. See CONF-700640.

Electron-beam float zone melting of vanadium in three passes at 3.9 in./hr in 4×10^{-10} torr vacuum resulted in resistance ratios of about 700 and a total impurity content of 50 wt ppM. The zoning reduced both carbon and oxygen content. However, while carbon removal was always accompanied by a lowering of the oxygen content, the reverse was not true. The removal of oxygen was probably accomplished by the formation and volatilization of VO. The mechanism for carbon removal was not clearly resolved. Nitrogen was not appreciably affected by electron-beam float zone melting. All metallic impurities, with the exception of Ta and W and possibly Si, were effectively volatilized. No evidence was found for zone refining action on any impurity. Vacuum outgassing further reduced the carbon and oxygen level. However, the oxygen removal was far more effective than the carbon. The nitrogen content increased, particularly on the specimens that lost about 40% in weight due to vanadium evaporation. However, the effect of vacuum outgassing was less on the highest purity as-zoned specimens. The same purification mechanisms apparently operated. (auth)

37938 PRODUCTION OF A CRACK-FREE ELECTROLYTIC COATING ON NICKEL–MOLYBDENUM ALLOYS. Chassaing, Elisabeth (CNRS, Vitry-sur-Seine, France). Compt. Rend., Ser. C; 272: 914-17(8 Mar 1971). (In French).

For a given bath, a density current threshold exists, above which crack free deposition occurs. The maximum layer thickness, free from scaling, is 40 μ. A greater deposited thickness may be obtained by performing the deposition in two stages, with different current densities. Similar coatings may be deposited on various metals and alloys provided that etching precautions, adapted to the support nature, are taken. (auth) (France)

37939 PREPARATION OF METALLIC DYSPROSIUM USING THE REACTION OF TANTALUM ON ITS DICARBIDE. Male, Germain; Trombe, Felix (CNRS, Montlouis, France). Compt. Rend., Ser. C; 272: No. 16, 1385-8(19 Apr 1971). (In French).

A new method for preparing rare earth metals using thermochemical data on carbides is described. Dysprosium carbide reduced by tantalum yields, after distillation, a metal containing 80.10^{-6} ppM of oxygen and 30.10^{-6} ppM of carbon. (France)

37940 WELDED JOINTS IN THE PRIMARY CIRCUIT OF NUCLEAR POWER STATIONS. Peter, Klaus; Meyer, Alfried. At. Strom; 17: 12-18(Jan 1971). (In German).

An account is given of the problems which arise in the welding of reactor pressure vessels and primary circuit lines. The requirements set for welding procedures, particularly for the manufacturer and the construction supervision, in order to achieve the high quality level, are described. By using a few typical examples explanations are given of the difficulties which arise, and which must be dealt with, due to the use of large-area partitions and other causes. Finally, there is a short discussion on the mechanics of fracture, the assumptions made and the limitations being listed. (auth)

37941 WELDING AND TESTING PROBLEMS WITH PRESSURE VESSELS OF LARGE WALL THICKNESS, PARTICULARLY WITH REACTOR VESSELS. Schaar, Kurt; Mueck, Guenther H.; Eisenlohr, Wolfdietrich. At. Strom; 17: 18-21(Jan 1971). (In German).

The manufacture of reactor vessels and reaction tanks for the chemical industry weighing up to 600 tons and a wall thickness of about 150 mm requires special considerations as to the choice of material, the manufacturing, and testing process. This paper deals with the relevant difficulties and outlines appropriate welding methods as well as the interpretation of test results. New manufacturing processes still under development are briefly referred to. (auth)

37942 PSEUDO-PLASTIC BEHAVIOR OF URANIUM–NIOBIUM ALLOYS. Jackson, Ross J.; Boland, Joseph F.; Frankeny, Julius L. (to Dow Chemical Co.). U. S. Patent 3,567,523. 2 Mar 1971. Filed 27 Sep 1968.

A process is described for achieving an unusual thermally recoverable and reversible, pseudo-plastic strain behavior in uranium–niobium alloys, as well as useful products prepared therefrom. The process comprises rapidly cooling a uranium–niobium alloy from the gamma region, plastically deforming at a temperature below 450°C, and subsequently heating or cooling the alloy to cause it to exhibit pseudo-plastic behavior. (Official Gazette)

37943 PREPARATION AND PROPERTIES OF LiPb, A NOVEL MATERIAL FOR SHIELDS AND COLLIMATORS. Frigerio, Norman A. (Argonne National Lab., Ill.); LaVoy, Leo L. Nucl. Technol.; 10: No. 3, 322-4(Mar 1971).

The preparation and properties of LiPb are described, and its use suggested for neutron shields, collimators, filters and antiscatter grids where gamma contamination must be kept at a minimum. The material is relatively inexpensive, easily handled and fabricated, and stable in air at temperatures over 200°C and in neutron fluxes of the order of 10^{12} n cm^{-2} sec^{-1}. (auth)

Properties Evaluations

Refer also to abstracts 37541, 39283, 39311, and 39358.

37944 (CONF-710310–1) PERFORMANCE OF TYPE 316 STAINLESS STEEL IN SODIUM–POTASSIUM EUTECTIC ALLOY DURING 32,600 HOURS SERVICE. Hoffman, T. L. (Idaho Nuclear Corp., Idaho Falls). [nd]. Contract AT(10-1)-1230. 18p. Dep. NTIS.

From National association of corrosion engineers high temperature symposium; Chicago, Ill. (22 Mar 1971).

The Waste Calcining Facility at the Idaho Chemical Processing Plant of Idaho Nuclear Corporation utilizes a fluidized-bed calciner for converting highly radioactive aqueous waste into granular solids. Heat is supplied to this calciner by circulating sodium–potassium (NaK) eutectic alloy at 760°C through a bayonet heat exchanger in the fluidized-bed of solids. Service test examinations were performed on the Type 316 stainless steel loop for circulating the NaK eutectic alloy. These examinations of the stainless steel loop revealed the cumulative effects of 32,600 hours of operation at temperatures of 590 to 780°C during eight years service. Although Type 316 stainless steel performed satisfactorily, the results showed that changes in mechanical properties and metallurgical effects occur with circulating nonisothermal NaK in contact with Type 316 stainless steel. Some mass transfer of alloying elements from the hot regions of the Type 316 stainless steel loop to the colder regions was observed. The mitigation of these effects is discussed. (auth)

37945 (JUL–680-RB) MEASUREMENT OF THE TEMPERATURE WITH METAL MONITORS USING SURFACE TENSION IN THE RANGE 780 TO 1555°C. Presser, K. H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). Jul 1970. 45p. (In German). Dep. NTIS (U. S. Sales Only).

The form alteration temperature of metal monitors was exactly determined experimentally under clearly defined and reproducible conditions of the heating in hydrogen, rare gas, and air atmospheres. In the range between 780 and 1555°C the pure metals Ag, Au, Cu, Ni, and Pd and the binary alloys Ag/Pd, Au/Pd, Cu/Pd, Ag/Au, Ag/Cu, Au/Cu, and Cu/Ni are suitable for monitors. Monitors are miniature molded bodies whose volume is about 1 mm^3 and whose surface relative to the volume is very great. With attainment of the form alteration temperature, the surface tension change induces form alteration completion in several seconds. The material to be melted assumes a spherical form with high probability. The form alteration temperature in the pure metals is practically identical with the melting temperature and in metal alloys it reaches values which deviate a maximum of ±2% from the liquidus curve. The reproducibility is ±⅓%. The high response accuracy is only guaranteed if the monitor surface retains its metallic polish during the heating. Therefore the monitor was enclosed in a gas-tight sealable capsule of aluminum oxide, quartz, or ferritic steel. Hydrogen or rare gas was used as a protective atmosphere. An accurate form alteration temperature can be assigned on the basis of the measurements and the phase diagram of each alloy. (tr-auth)

37946 (LA–4638) THERMODYNAMIC PROPERTIES OF $PuFe_2$ FROM EMF MEASUREMENTS. Campbell, George M. (Los Alamos Scientific Lab., N. Mex.). Jan 1971. Contract W-7405-eng-36. 4p. Dep. NTIS.

The free energy of formation of $PuFe_2$ was measured over the temperature range 792 to 1106°K by monitoring the emf of the cell $Pu(s,l)/PuCl_3$, $LiCl-KCl/PuFe_2 + Fe(s)$. Transient potential methods were used to ensure reversibility and singularity of the electrode reactions. Sufficient precision was obtained to permit the calculation of thermodynamic and thermal functions at the temperature of the measurements and to make extrapolated estimates at lower temperatures. (auth)

37947 (ORNL–4660) MEASUREMENT AND CORRELATION OF THERMAL RESISTANCES OF UN–METAL INTERFACES. Williams, R. K.; Banks, T. E.; McElroy, D. L. (Oak Ridge National Lab., Tenn.). May 1971. Contract W-7405-eng-26. 54p. Dep. NTIS.

Data were obtained on thermal contact resistance for contact interfaces between UN and several other metals in vacuum at about 50°C: UN–In, UN–type 1100 Al, UN–Cu, UN–V–15% Cr–5% Ti, UN–Mo, UN–UN, and three UN–type 302 stainless steel interfaces. Many variables affected the results, and the correlation of the data showed the relative importance of stress, hardness, thermal conductivity, and surface topography. The correlation obtained from the data also suggests means for reducing thermal contact resistance in fuel elements; these possibilities are discussed. (auth)

37948 (RFP–1456) ADSORPTION ON PLUTONIUM, PART I. NITROGEN, OXYGEN, HYDROGEN, AND CARBON MONOXIDE. Adams, Richard O.; DiGiallonardo, Anthony (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 9 Jun 1971. Contract AT(29-1)-1106. 7p. Dep. NTIS.

The sticking probabilities and quantities of gas adsorbed on a clean plutonium surface are measured. Oxygen, nitrogen, hydrogen, and carbon monoxide are the adsorbing gases. The clean plutonium surface is prepared by vapor deposition in high vacuum. (auth)

37949 (WAPD-TM–895) FRACTURE TOUGHNESS OF LOW-STRENGTH STEELS. Seman, D. J.; Kallenberg, G. P.; Towner, R. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1971. Contract AT-11-1-GEN-14. 143p. Dep. NTIS.

The recent fracture-toughness data on low-strength steels either obtained by Bettis or reported in the literature are summarized. The data are first analyzed with respect to technical advances in the state of the art of fracture-mechanics measurement techniques, and second, presented as a compilation of the significant data available for low-strength steels. The grades of steel included are: A302B, A533 Grade B, A508 Class 2, and A508 Class 4. The data include both static and dynamic loaded specimens. Irradiated materials fracture-toughness tests and tests on weld and heat-affected-zone materials are included. (auth)

37950 ELECTRIC PROPERTIES OF TANTALUM FILMS. CONDUCTIVITY, THERMAL EVOLUTION, MEAN FREE PATH. Desserre, Jacques; Goulet, Jean-Claude (Rouen Univ., Mont-Saint-Aignan, France). Compt. Rend., Ser. B; 272: No. 13, 808-11(29 Mar 1971). (In French).

Tantalum films obtained by condensation in vacuum on a Vycor glass (96% SiO_2, 4% boron anhydride) were studied. The optimum temperature required for depositing tantalum, its electric resistivity at 0°C, its temperature coefficients between 25 and 500°C for thicknesses between 50 and 5,500 Å, and the mean free path of the electrons were determined. These results are interpreted. (France)

37951 PERMANENT MAGNETS. Becker, Joseph J. Sci. Amer.; 223: No. 6, 92-100(Dec 1970).

After a survey of the characteristics of hard and soft magnetic materials, the unusual properties of cobalt alloys with rare-earth metals are described. Ways of producing magnetic materials with high coercive forces are discussed, with Co_5Sm as an example. Some possible applications of materials with high coercive force are considered. (D.L.C.)

37952 CREEP-RUPTURE PROPERTIES OF C-129Y IN VACUUM. Stephenson, R. L. (Oak Ridge National Lab., Tenn.). J. Vac. Sci. Technol.; 7: S112-15(Nov-Dec 1970).

From 2nd International Vacuum Metallurgy Conference, Anaheim, Calif. See CONF–700640.

Creep–rupture properties for C-129Y (Nb–10% W–10% Hf–0.1% Y) to 1000 hr are presented at 980, 1095, and 1205°C. Improvements in strength at 980 and 1205°C can be achieved by pretest annealing at higher temperatures. These improvements are achieved only at the expense of a significant loss in ductility. (auth)

37953 DIFFUSION OF H_2, D_2, AND T_2 IN SINGLE-CRYSTAL Ni AND Cu. Katz, L.; Guinan, M.; Borg, R. J. (Univ. of California, Livermore). Phys. Rev., B; 4: No. 2, 330-41(15 Jul 1971).

Diffusion coefficients have been obtained for H_2, D_2, and T_2 as a function of temperature in both Cu and Ni. The absolute-rate-

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theory formalism as proposed by Vineyard provides an adequate explanation of the results if quantum corrections and anharmonic effects are taken into consideration. The Ni results are especially affected by the failure of the harmonic approximation that apparently holds for Cu. (auth)

37954 THERMAL CONDUCTIVITY AND LORENTZ NUMBER OF THE HEAVY RARE-EARTH METALS. Ratnalingam, R.; Sousa, J. B. (Clarendon Lab., Oxford). J. Low Temp. Phys.; 4: No. 4, 401-14(Apr 1971).

A detailed investigation of the thermal conductivity of pure, heavy rare-earth metals was made in the range of temperatures 0.3 to 4.2°K. The results obtained on the 10 samples investigated (Gd, Dy, Ho, Er, Yb, and Tb) show that the thermal conductivity can be readily separated into a linear and a quadratic term in temperature. The linear term, when related to the residual electrical resistivity, gives Lorentz numbers that are remarkably close to the theoretical value and this indicates an electronic linear contribution to the thermal conductivity; the experimental evidence available suggests that the quadratic term is due to a phonon contribution. Interesting information on the scattering mechanisms for electrons and phonons is also obtained. (auth)

37955 THERMAL CONDUCTIVITY OF α-URANIUM BETWEEN 5 AND 100 K. Hall, R. O. A.; Lee, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Low Temp. Phys.; 4: 415-19(Apr 1971).

The thermal and electrical conductivities of uranium have been measured over the temperature range 5 to 100°K. Both in the "as-received" condition and after annealing, the thermal conductivity results show a maximum at low temperatures followed by a shallow minimum with increasing temperature. Typical values for the annealed specimen were 65 W m^{-1} K^{-1} at 15°K and 35 W m^{-1} K^{-1} at 100°K. The temperature dependence can be explained by an electronic conductivity increasing with temperature, and a significant lattice contribution which is almost constant over the temperature range 40 to 100°K. A small secondary peak centered at 55°K is observed associated with the $\alpha - \alpha_0$ phase transition. (auth)

37956 STANDARD SPECIFICATION FOR TANTALUM ROD AND WIRE. ASTM B 365-70. Philadelphia; American Society for Testing and Materials (1970). 2p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers rods and wires of unalloyed tantalum in the following grades: powder metallurgy, arc cast, and electron-beam cast. (auth)

37957 SUPERPLASTICITY IN LEAD–CADMIUM ALLOYS. Rao, S. Srinivasa; Sivakesavam, O.; Ghude, S. H.; Tamhankar, R. V. (Defence Metallurgical Research Lab., Hyderabad, India). Trans. Indian Inst. Metals; 23: No. 4, 44-8(Dec 1970).

Considerable attention has been paid in the recent years to the development of new superplastic alloys. Four alloys from the lead-cadmium system, including the eutectic, are tested in tension in a modified Hounsfield tensometer, over a range of strain rates (10^{-4} to 1 min^{-1}) at room temperature. Only three alloys exhibited superplasticity with extensions greater than 900%. The duplex alloy of low cadmium content did not respond to superplasticity. Alloys of cadmium content greater than the eutectic are found to display superplasticity to a greater degree than the eutectic alloy. The grain size of these alloys is found to be 5 μm. From the equation $\sigma = K\dot{\epsilon}^m$, the strain rate sensitivity coefficient, m, is calculated at each of the cross head velocities ranging from 10^{-4} to $^{-1}$ in/min. The results are discussed in the light of the previous work on superplastic low melting alloys. (auth)

37958 INFLUENCE OF NITROGENATION ON HARDNESS AND WEAR RESISTANCE OF MOLYBDENUM ALLOYS. Lakhtin, Yu. M.; Kogan, Ya. D. (Moscow Auto and Railroad Inst.). Fiz.-Khim. Mekh. Mater.; 6: No. 5, 15-18(1970). (In Russian).

The effects of nitrogenation on the surface hardness and wear properties of Mo alloys were studied. Nitrogenized coatings of Mo had a hardness of approximately 2000 kg/m^2, and exhibited high wear resistance. The optimum nitrogenization was obtained at 1000°C for 3 hr. (tr-auth)

37959 ATOMIC ABSORPTION SPECTRUM METHOD FOR DETERMINING HEAT OF SUBLIMATION OF REFRACTORY METALS. Nikolaev, G. I.; Nemets, A. M. Zh. Prikl. Spektrosk.; 13: 695-7(Oct 1970). (In Russian).

A linear relation between temperature and optical density was found for Ti at temperatures from 1630 to 2400°K and for Mo at temperatures from 2200 to 2400°K. The results obtained were used for calculating the standard values of heat of sublimation for Mo and Ti. The values calculated were 111.0 kcal/g-atom for Ti and 164.8 kcal/g-atom for Mo. (R.V.J.)

37960 STANDARD SPECIFICATION FOR ZIRCONIUM AND ZIRCONIUM ALLOY SHEET, STRIP, AND PLATE FOR NUCLEAR APPLICATION. ASTM B 352-67. Philadelphia; American Society for Testing and Materials (1968). 9p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers hot- and cold-rolled zirconium and zirconium alloy sheet, strip, and plate. Three grades designated as reactor grade zirconium and zirconium-tin alloys RA-1, R-1, and RA-2, suitable for use in nuclear application are described. The products covered in this specification include the following forms and sizes: sheet, 24 in. or more in width; under 0.187 in. in thickness; strip, less than 24 in. in width; under 0.187 in. in thickness; and plate, over 10 in. in width; 0.187 in. and over in thickness. (auth)

37961 STANDARD SPECIFICATION FOR WROUGHT ZIRCONIUM AND ZIRCONIUM ALLOY SEAMLESS AND WELDED TUBES FOR NUCLEAR SERVICE. ASTM B 353-69. Philadelphia; American Society for Testing and Materials (1969). 6p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers seamless and welded wrought zirconium and zirconium-alloy tubes for nuclear application. Three grades, designated as reactor grade zirconium R-1, and zirconium-tin alloys RA-1 and RA-2, suitable for nuclear application are described. (auth)

37962 NIOBIUM-BASE ALLOYS AND THEIR HEAT TREATMENTS. Alheritiere, Edouard; Syre, Robert (to Trefimetaux GP). French Patent 2,032,105. Nov 1970. Filed 19 Feb 1969. (In French).

A Nb-base alloy containing W, Zr, Hf, C, and B was developed. The alloy is characterized by an atomic ratio (Hf + Zr)/(C + 0.5 B) between 0.5 and 1.5, and properties induced by heating at 1800 to 2000°C and subsequent cooling; either good malleability when hot or cold or a high creep resistance when hot. These alloys are used in the manufacture of turbine elements which must have a good creep resistance when hot. (France)

37963 INVESTIGATION OF SELF-DIFFUSION IN THE SYSTEMS Nb–V, V–Pd, AND Pb–Nb. Ugaste, Yu. E.; Lazarev, E. M.; Pimenov, V. N. Izv. Akad. Nauk SSSR, Metal.; No. 2, 211-15(Mar-Apr 1971). (In Russian).

Systems were deliberately chosen as representing continuous solubility (Nb–V) and limited solubility (Nb–Pd, V–Pd), and as metals possessing different lattices (Nb, bcc V; and fcc Pb). In the system Nb–Pd at 1200°C, the compound Nb_2Pd was not observed. The coefficients of self-diffusion in the systems Nb–V, Nb–Pd, and Pb–V were functions of the concentration, varying, e.g., in the system Nb–V, by nearly two orders of magnitude. The method of self-diffusion may be used to confirm phase diagrams constructed by other methods. (K.S.W.)

37964 SATURATION BY CARBON OF LIQUID MOLYBDENUM, TUNGSTEN, AND RHENIUM IN AN ARC FURNACE. Kashin, V. I.; Klibanov, E. L.; Tsilosani, A. G.; Tylkina, M. A.; Konieva, L. Z. Izv. Akad. Nauk SSSR, Metal.; No. 2, 39-45 (Mar-Apr 1971). (In Russian).

The solubilities and diffusion of carbon in liquid Mo, W, and Re were measured at temperatures up to 4000°C. C is more soluble in Re than in Mo or W, but diffusion in Re is considerably less. (tr-auth)

37965 EFFECT OF CARBON ON THE STRUCTURE AND MECHANICAL PROPERTIES OF TUNGSTEN MONOCRYSTALS. Kopetskii, Ch. V.; Orzhekhovskii, V. L.; Pashkovskii, A. I.; Chuzhko, R. K. Izv. Akad. Nauk SSSR, Metal.; No. 2, 124-9 (Mar-Apr 1971). (In Russian).

The structure and mechanical properties of W crystals with carbon contents of 0.01 to 0.001% were investigated under deformation in the temperature range 77 to 473°K. Decreasing the C content increases the ductility, particularly at low temperatures, and causes a more uniform distribution of dislocations as well as a coarsening of the grain structure of W. The data confirm the dependence of yield limits of constriction, of relative elongation, and the type of crystal disintegration, on the orientation of the elongation axes. (tr-auth)

37966 EFFECTS OF ALLOYING WITH SMALL AMOUNTS OF TITANIUM AND ZIRCONIUM ON THE PROPERTIES OF NIOBIUM. Prokoshkin, D. A.; Vasil'eva, E. V.; Markova, S. A. Izv. Akad. Nauk SSSR, Metal.; No. 2, 130-5(Mar-Apr 1971). (In Russian).

A study was made of Nb alloys containing 1 to 6 at. % Ti and 0.5 to 5 at. % Zr following extrusion and annealing. Microstructure, hardness, and mechanical properties were investigated at room

temperature and creep by deformation was determined at 1100°C at stresses ranging from 8 to 20 kg/mm². A micro-scanning technique studied the distribution of the alloying elements in the structure of Nb. Zr concentrates itself in grain boundaries, whereas Ti is uniformly distributed throughout the grains. Both Ti and Zr increase the hardness and resistance to creep of Nb at room temperature. (tr-auth)

Structure and Phase Studies

37967 DEFORMATION SUBSTRUCTURE IN BERYLLIUM AFTER PRISM SLIP. Kannan, V. C.; Weissmann, S. (Rutgers-The State Univ., New Brunswick, N. J.). J. Appl. Phys.; 42: No. 7, 2632-8(Jun 1971).

The development of cell structure during room-temperature tensile deformation of beryllium oriented for prism slip was studied by a combination of a new x-ray diffraction technique (synergy method) and transmission electron microscopy. It was convenient to divide the development of the cell structure into three stages. In stage one, dislocations moving on the prism plane pulled out small segments of dislocations lying on the basal plane to form long dipoles and numerous pinched-off loops. During the second stage, dense dislocation clusters developed which became interconnected by dislocation tangles. The final stage consisted of the formation of well-developed cell walls with regular hexagonal networks of dislocations. The striking feature of all the stress–strain curves was the low work-hardening rate extending up to $\epsilon = 15\%$ strain. The low work-hardening rate was ascribed to nucleation and propagation of new slip bands into hitherto undeformed volumes of the crystal. (auth)

37968 OBSERVATIONS ON MORPHOLOGY AND FINE STRUCTURES OF ZIRCONIUM MARTENSITES. Banerjee, S.; Krishnan, R.; Asundi, M. K. (Bhabha Atomic Research Centre, Trombay, India). Trans. Indian Inst. Metals; 23: No. 4, 8-12 (Dec 1970).

The structures of martensite, obtained by quenching iodide and sponge zirconium, were studied by optical and electron microscopy. The morphologies of these martensites, as observed in an optical microscope, differ significantly. Both acicular and massive morphologies were obtained depending on the impurity level and quenching conditions. The surface tilt, produced during the transformation, reveals the platelets which constitute a massive grain. Electron microscopic observations confirm the presence of parallel platelets of martensite in massive martensite structure. These platelets are free from internal twins indicating the mode of second shear during the process of transformation. The dislocation distribution of this slipped martensite structure is illustrated in a number of micrographs. The platelets with internal twins are observed in acicular martensites. (auth)

37969 INFLUENCE OF LIQUIDUS ON THE STABILITY OF LIQUID EUTECTIC SYSTEMS. Kumar, Rajendra; Sivaramakrishnan, C. S. (National Metallurgical Lab., Jamshedpur, India). Trans. Indian Inst. Metals; 23: No. 4, 49-52(Dec 1970).

The binary metallic solutions, in general, can be classified into two groups where the liquidus shows and where it does not show a smooth concentration dependence. It is shown that the homogeneity of these solutions in the composition range of inflected liquidus cannot be taken for granted. Under suitable conditions the solutions break up into conjugate liquids having the composition of the extremities of the inflected portion of the liquidus. That this is so was experimentally observed in the systems like lead-antimony and lead-cadmium by a novel centrifuging technique. (auth)

37970 COBALT-BASE SUPERALLOYS, 1970. Sullivan, C. P.; Donachie, M. J. Jr.; Morral, F. R. Cobalt Monograph Series. Brussels; Centre d'Information du Cobalt (1970). 78p.

The composition of cobalt-base superalloys containing carbides, intermetallic compounds, dispersoids, and minor element additions is described. Information is reviewed on cobalt-base superalloys including: grain structure; oxidation, hot corrosion, and coating; allotropic transformation; dislocation structure; processing techniques; and thermal fatigue and bow. (G.M.C.)

37971 SOLIDUS AND LIQUIDUS OF THE U–Zr–Nb SYSTEM. Badaeva, T. A.; Kuznetsova, R. I. Izv. Akad. Nauk SSSR, Metal.; No. 2, 188-90(Mar-Apr 1971). (In Russian).

Isotherms of the solidus and liquidus were constructed for the ternary system U–Zr–Nb using thermal analysis data. The presence of a continuous series of γ-solid solutions was confirmed. Solidus and liquidus curves were partially constructed for the following binary systems: U–Zr, U–Nb, and Zr–Nb. (tr-auth)

37972 PHASE STUDIES IN ALLOYS OF REFRACTORY METALS. Kocherzhinskii, Yu. A. Izv. Akad. Nauk SSSR, Metal.; No. 2, 195-9(Mar-Apr 1971). (In Russian).

A short review is presented of high-temperature x-ray diffraction techniques, dilatometry, microscopy, and other instrumental methods for investigating systems of metals such as Mo, W, and Re. 46 references. (K.S.W.)

37973 PHASE DIAGRAM OF THE SYSTEM V–Sc. Savitskii, E. M.; Naumkin, O. P.; Efimov, Yu. V. Izv. Akad. Nauk SSSR, Metal.; No. 2, 178-9(Mar-Apr 1971). (In Russian).

The V–Sc phase diagram was constructed by means of microstructural, x-ray and thermal analysis, hardness, microhardness, and the superconducting transition temperature. A eutectic reaction was observed at 1410°C and 86% Sc. A eutectic reaction also occurred at 1300°C and 99% Sc. The maximum mutual solubility of V and Sc at the eutectic temperature was approximately 2 at. %. Alloying of V with Sc raises its hardness and transition temperature to the superconducting state. (tr-auth)

37974 PHASE STUDIES OF THE SYSTEM W–Mo–Ta. Pryakhina, L. I.; Polyakova, R. S.; Gromova, V. G.; Myasnikova, K. P.; Ozhimkova, O. V. Izv. Akad. Nauk SSSR, Metal.; No. 2, 180-2 (Mar-Apr 1971). (In Russian).

The presence of continuous solid solutions was established in W–Mo–Ta alloys. A marked hardening occurs when W is alloyed with Ta and Mo because of the solid solutions formed. The phase diagram for the W–Mo–Ta system is given establishing the region of the most refractory and stable compositions in the vicinity of W–Ta. (tr-auth)

37975 PHASE DIAGRAMS. MATERIALS SCIENCE AND TECHNOLOGY. VOLUME III. THE USE OF PHASE DIAGRAMS IN ELECTRONIC MATERIALS AND GLASS TECHNOLOGY. Alper, Allen M. (ed.). Refractory Materials. A Series of Monographs. Volume 6. New York; Academic Press, Inc. (1970). 338p.

Eight papers are included. A separate abstract was prepared for each of the six papers in scope for NSA. (M.H.R.)

For abstracts of individual chapters see: 37976, 37977, 38026–38028, and 38319.

37976 USE OF PHASE DIAGRAMS IN CRYSTAL GROWTH. Nielsen, J. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Monchamp, R. R. Refract. Mater.; 6: 1-52(1970).

Results of studies on thermodynamic conditions under which crystal growth is stable are discussed. Emphasis is placed on solid–liquid equilibria and on solid–vapor equilibria. Information is included on crystal growth methods, and on growth from melts, solutions, and vapors. (J.R.D.)

37977 RAPIDLY QUENCHED (SPLAT-COOLED) METASTABLE ALLOY PHASES; THEIR PHASE-DIAGRAM REPRESENTATION, PREPARATION METHODS, OCCURRENCE, AND PROPERTIES. Giessen, B. C. (Northeastern Univ., Boston); Willens, R. H. Refract. Mater.; 6: 103-41(1970).

The preparation of metastable phases by rapid quenching from the liquid phase is described along with the alloy constitution changes associated with formation of these alloys and their properties. Information is included on phase diagram representation of metastable alloys, preparation methods for metastable phases, constitution changes during rapid quenching, and properties of splat-cooled metastable phases. (J.R.D.)

37978 FAZOVYE PREVRASHCHENIYA. (Phase Transformations). Svechnikov, V. N. (ed.). Respublikanskii Mezhvedomstvennyi Sbornik, Metallofizika 32. Kiev; Naukova Dumka (1970). 160p.

Twenty-three papers are included in the book. A separate abstract was prepared for each of three papers. The remaining papers were not in scope for NSA. (R.C.K.)

For abstracts of individual papers see: 37979, 37980, and 38136.

37979 PHASE EQUILIBRIA IN THE SYSTEM Mo–Nb–Hf. Svechnikov, V. N.; Shurin, A. K.; Alfintseva, R. A. (Inst. of Metal Physics, Kiev). pp 25-7 of Fazovye Prevrashcheniya. /Svechnikov, V. N. (ed.). Kiev; Naukova Dumka (1970). (In Russian).

Ternary diagrams were constructed for the phase equilibria at 1500 and 1800°C for Mo–Nb–Hf. Metallographic, x-ray, and durometric methods of analysis were employed, and the effect of the composition on the hardness and parameters of the bcc crystal lattice was studied. (tr-auth)

37980 EFFECT OF Zr ON THE REGION OF α–γ–δ POLYMORPHISM IN THE TERNARY SYSTEM Fe–Cr–Zr. Svechnikov, V. N.; Spektor, A. Ts. (Inst. of Metal Physics, Kiev). pp 33-8 of

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Fazovye Prevrashcheniya. /Svechnikov, V. N. (ed.). Kiev; Naukova Dumka (1970). (In Russian).

The basic features of the region of $\alpha-\gamma-\delta$ polymorphism are presented for the Fe–Zr neighborhood of the ternary system Fe–Cr–Zr. The methods used included microstructure, x-ray, dilatometry, differential-thermal analysis, and magnetometry. A closed surface apparently forms a boundary between the polymorphic region and the remainder of the system. The results of this study may be extended to the ternary system Fe–Cr–M wherein M represents an element which alloys with iron to form the so-called reciprocal peritectic transition. (tr-auth)

37981 LANG TOPOGRAPHY OF DISLOCATIONS IN CADMIUM. Badrick, A. S. T.; Puttick, K. E. (Univ. of Surrey, Guilford, Eng.). Phil. Mag.; 23: 585-610(Mar 1971).

A method is described of preparing oriented single crystals of cadmium sufficiently perfect for x-ray transmission topography. The method, involving carefully controlled cooling, is thought to have general applicability as a means of achieving low dislocation densities in metals. The main observations of importance are of large (~50 μm) edge dislocation loops in the basal plane. Contrast effects in $10\bar{1}0$ and $10\bar{1}2$ reflections indicate that certain loops are of pure edge type with ⟨c⟩ vectors, others being of ⟨c + a⟩ type; it is believed that these are the result of vacancy condensation on preexisting dislocations. Certain loops are observed to shrink over a period of days at room temperature, and the kinetics of this process are consistent with known data on self-diffusion. Other observations more briefly discussed are: bars of contrast attributed to unresolved stacks of ⟨a⟩ vector loops; contrast effects in sections parallel to $(10\bar{1}0)$; comparison of dislocation densities estimated by topography and by etch-pitting; aging effects in foils, including loop growth in certain areas and a long-term deterioration in crystal quality attributed to small fatigue strains. (auth) (UK)

Radiation Effects

Refer also to abstracts 38539, 38552, 38553, 38561, 39142, 39143, 39166, 39211, 39294, and 39351.

37982 (HEDL-SA-159) ANALYSIS OF SWELLING DATA FOR STAINLESS STEEL BASED ON THE LINDHARD THEORY OF ENERGY PARTITION. Doran, D. G.; Simons, R. L.; McElroy, W. N. (Hanford Engineering Development Lab., Richland, Wash.). May 1971. Contract AT(45-1)-2170. 16p. (CONF-710601-1). Dep. NTIS.

From International conference on radiation-induced voids in metals; Albany, N. Y. (9 Jun 1971).

A major problem in predicting swelling behavior for reactor design purposes is the proper correlation of data obtained under different irradiation conditions. As part of a study of the implications of a spectrally sensitive displacement model on the analysis of swelling data, a new displacement cross section was calculated for stainless steel based on the energy partition theory of Lindhard et al. Void volume data are being collected from several laboratories and the best possible spectrum and fluence values associated with each data point. These spectra are being used to calculate the fraction F of flux exceeding 0.1 MeV, the spectrally averaged gross displacement cross sections $\overline{D}$, and mean neutron energies $\overline{E}$. The relationships between $\overline{D}$, $\overline{E}$ and F are presented for a wide range of EBR-II spectra and for several other reactors. An example is given to illustrate the differences in predictions of void formation that may result from using different measures of exposure. The relation between helium production rate, another important spectrally dependent quantity, and displacement rate in EBR-II spectra is presented. (auth)

37983 (IAEA-117, Paper 8a) ROLE OF GRAIN SIZE AND IRRADIATION TEMPERATURE IN THE HARDENING OF LOW-CARBON STEELS. Stefanovich, V. M. (International Atomic Energy Agency, Vienna (Austria)). 1970. 8p. (CONF-690727-14). NTIS (U. S. Sales Only).

From Report of a meeting of specialists; Tokyo, Japan (21 Jul 1969).

Combined effects of the irradiation temperature and grain size on radiation hardening of low-carbon steel irradiated up to the same neutron dose of about 2×10^{18} n cm^{-2} (E > 1 MeV) are described. The earlier studies on mild steels were extended to higher irradiation temperatures. The effects of irradiation temperature upon the changes of mechanical properties and their correlation with the defect structure of unirradiated specimens were studied systematically. (auth) (INIS)

37984 EFFECTS OF IRRADIATION TEMPERATURE AND PREINJECTED GASES ON VOIDS IN ALUMINUM. Farrell, K.; Wolfenden, A.; King, R. T. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 8: No. 1-2, 107-14(Mar 1971).

Voids in high-purity aluminum irradiated to a fast (E > 1 MeV) fluence of 4×10^{20} n/cm^2 at 125 (0.43T_m) and 150°C (0.45T_m) are fewer in number but very much larger in size than those in material irradiated at 55°C (0.35T_m). Additionally, at 125 and 150°C, the voids adopt a variety of shapes including plates, ribbons, cylinders, and more equiaxed polyhedra, and are frequently associated with particles of transmutation-produced silicon. At the higher temperatures, voids are larger near grain boundaries than in grain interiors. Injection of hydrogen or helium prior to irradiation causes an increase in the number of voids and a corresponding decrease in size in specimens irradiated at 150°C; 3 at. ppM He is more effective than either 3 or 9 at. ppM H. The gases do not appear to influence swelling. A commercial purity (99%) aluminum subjected to the same irradiation treatments did not develop voids whether preinjected with gases or not; the visible radiation damage consisted solely of small loops on or near grown-in dislocations. (auth)

37985 HELIUM MIGRATION IN PALLADIUM. II. SCANNING ELECTRON MICROSCOPY EXAMINATION OF HIGH CONCENTRATION SAMPLES. Thomas, G. J. (Sandia Labs., Albuquerque, N. Mex.); Bauer, W.; Holt, J. B. Radiat. Eff.; 8: No. 1-2, 27-30(Mar 1971).

Scanning electron microscopy has been used to examine bulk phenomena of palladium samples annealed at 1200°C after implantation to a dose of 10^{17} He atoms/cm^2 at 5 MeV. A 3-μ deep porous layer was found at a depth of 10.9 $\mu \pm 0.3$ μ. Wide grain boundaries (microcracks) extended from this layer to the top surface of the sample. (auth)

37986 IRRADIATION OF TUNGSTEN UNDER UNIAXIAL STRESS AT LOW TEMPERATURE. Ponsoye, J. (CEN, Fontenay-aux-Roses, France). Radiat. Eff.; 8: No. 1-2, 13-26 (Mar 1971). (In French).

Variations of length and resistivity were measured simultaneously in tungsten irradiated at 20°K by fission fragments and uniaxially pulled (stress σ). Resistivity changes are completely stress-independent. In particular neither $(\Delta\rho)_0$ nor $(\Delta\rho^\infty)$ depends on σ. The same behavior applies for $(\Delta L)_0$. On the other hand, for high irradiation doses, the length change ΔL is a function of σ: ΔL, which tends to a saturation if $\sigma = 0$, increases continuously if $\sigma \neq 0$. The value of $(\Delta L)_0/(\Delta\rho)_0$ gives an evaluation of the formation volume of Frenkel pairs: $v_{p.F.} = 0.16\ v_{at}$. This volume has also been measured in iron ($1.0\ v_{at}$) and in molybdenum ($0.6\ v_{at}$). It has also been observed that the recovery of radiation defects was enhanced by the presence of the stress. A model is proposed in which most of the defects cluster into dislocation loops. Without an applied stress, the four equivalent Burger's vectors $\frac{1}{2}$ ⟨111⟩ are equally populated: there is an isotropic increase of volume without a change of shape. Under a stress, this four-fold degeneracy is generally raised and then, a change of shape is superimposed to the change of volume: a nonsaturated length change then takes place. This description, which recalls the phenomenon of growth in anisotropic metals, correctly explains our results and more specifically the constancy of $(\Delta\rho)_0$ and of $(\Delta L)_0$ with respect to σ. (auth)

37987 RELATION BETWEEN SURFACE STRUCTURES AND SPUTTERING RATIOS OF COPPER SINGLE CRYSTALS. Elich, J. J. Ph. (FOM-Instituut voor Atom- en Molecuulfysica, Amsterdam); Roosendaal, H. E.; Kersten, H. H.; (and others). Radiat. Eff.; 8: No. 1-2, 1-11(Mar 1971).

Polished (100) Cu crystals have been bombarded at target temperatures of 204, 294, and 456°K by 10- and 20-keV Ne^+ ions up to a total dose of 1.7×10^{19} ions/cm^2. The plane of incidence was chosen to be a {100} plane perpendicular to the surface. Measurements have been performed for incident angles between 36 and 44° with respect to the surface normal. In this angular interval the sputtering ratio and the surface structure have been studied by weight-loss and replica electron microscope techniques respectively. At target temperatures of 204 and 294°K, an anomaly was observed in the curve of the sputtering ratio versus angle of incidence. A small peak appears where the curve slopes towards the ⟨110⟩ minimum. The position and height of the peak are a function of target temperature and ion energy. This sputtering submaximum is accompanied by the formation of ⟨100⟩ oriented furrows perpendicular to the ion beam. The nucleation of this relief is tentatively discussed in terms of local deviations from perfection of the surface, which might be due to a singularity in the production of focusing collisions influencing the damage structure. The growth of the furrows and the submaximum in the sputtering ratio are discussed in terms of the angle between the ion beam and the characteristic {110} side of the furrows. These sputtering and faceting phenomena have not been observed for 20-keV Ar^+ ion bombardment nor generally under bombardment at a target temperature of 456°K. (auth)

37988 RECOMMENDED PRACTICE FOR SURVEILLANCE TESTS FOR NUCLEAR REACTOR VESSELS. ASTM E 185-70. Philadelphia; American Society for Testing and Materials (1970). 5p. Available from American Society for Testing and Materials, Philadelphia.

This recommended practice covers procedures for irradiating and testing tension, impact, and other test specimens for the purpose of monitoring and evaluating, at periodic intervals, the radiation-induced changes occurring in the mechanical properties of the reactor vessel of nuclear reactors where such programs are deemed necessary. (auth)

37989 RECOMMENDED PRACTICE FOR EFFECTS OF HIGH-ENERGY RADIATION ON THE MECHANICAL PROPERTIES OF METALLIC MATERIALS. ASTM E 184-62. Philadelphia; American Society for Testing and Materials (1964). 5p. Available from American Society for Testing and Materials, Philadelphia.

This recommended practice covers special procedures for selection of a material and tests for radiation studies, the determination of radiation conditions, conducting tests for the mechanical properties of irradiated metallic materials, and the reporting of data. This recommended practice should achieve better correlation and interpretation of new data in the field of radiation effects testing. While primarily intended to apply to steels, this recommended practice may be applied to any appropriate metallic material. In addition to tests for mechanical properties, these procedures should be helpful in planning other types of radiation effects testing. (auth)

37990 VOID FORMATION IN IRRADIATED NICKEL 270. Stiegler, J. O.; Bloom, E. E. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 8: No. 1-2, 33-41(Mar 1971).

Nickel 270 (99.98 percent nominal purity) was irradiated in EBR-II to fluences ranging from 1×10^{18} to 1.5×10^{22} neutrons/cm^2 at temperatures between 375 and 525°C. Voids were observed in all specimens in concentrations of 1 to 3×10^{14} cm^2, independent of temperature and fluence. At low fluences the voids were nonhomogeneously distributed. These observations are interpreted in terms of void nucleation on sites existing in the material prior to irradiation. The results are compared with other observations on nickel of comparable and higher purity. Large differences exist not only in the magnitude of void concentrations but also in temperature and fluence dependencies. These differences indicate that a single void nucleation mechanism is not operative and that impurities play an important role in determining the nature and amount of damage produced by neutron irradiation at elevated temperatures. (auth)

37991 INFLUENCE OF IRRADIATION TEMPERATURE ON THE CREEP-RUPTURE PROPERTIES OF HASTELLOY-N. McCoy, H. E.; Gehlbach, R. E. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 11: No. 1, 45-60(May 1971).

The variation of the postirradiation creep-rupture properties with irradiation temperature was evaluated for air- and vacuum-melted Hastelloy N. The air-melted material was high in silicon and formed a stable carbide of the M_6C type. The properties of this material were not dependent upon the irradiation temperature over the range studied. The vacuum-melted alloys formed a M_2C-type carbide whose size and morphology depended markedly upon the irradiation temperature. When the carbides were finely dispersed by irradiation at about 650°C, the postirradiation properties were equivalent to those of the air-melted material. Irradiation at about 760°C resulted in coarser dispersions of the M_2C carbide and inferior postirradiation properties. (auth)

37992 CALORIMETRIC DETERMINATION OF RELATIVE GAMMA HEATING IN MATERIALS OF VARIOUS THICKNESSES AND ATOMIC NUMBERS. Reilly, Harry J.; Peters, Lawrence E. Jr. (Lewis Research Center, Cleveland). Nucl. Technol.; 11: No. 1, 89-95(May 1971).

A calorimeter was made to determine the relative amount of gamma heating, in watts/gram, in different materials as a function of thickness and atomic number. The experiment was performed in the NASA Plum Brook Mockup Reactor, which has a typical light water test reactor gamma spectrum. Carbon, aluminum, tin, and lead specimens in slab geometry were irradiated. The results showed no significant difference in the gamma heating in carbon and aluminum, but the heating in the other materials was greater than that in these elements. The thinner specimens had higher heating rates. The calorimeter was also used to determine the gamma heating effect in an irradiation experiment mockup having cylindrical geometry. The result showed good agreement with an expected value obtained from the slab geometry data. A theoretical analysis of the relative gamma heating was made using a one-dimensional multi-group transport program. It was concluded that the analysis and measurements agreed qualitatively and that quantitative differences were attributable mostly to geometrical effects. The results appear to be applicable to nuclear reactor experiment designs and to other reactor problems as well. (auth)

Ceramics and Cermets

Preparation and Fabrication

Refer also to abstracts 37339, 37401, 37438, and 37540.

37993 (A/CONF.49/P-63) U. S. PROGRAM FOR DEVELOPMENT TO MANUFACTURE HIGH QUALITY FAST REACTOR FUELS. Roake, W. E. (Hanford Engineering Development Lab., Richland, Wash.); Weber, C. E. (Atomic Energy Commission, Washington, D. C.); Wiese, D. H. (Carpenter Technology Corp., San Diego, Calif.); Caldwell, C. S. (Nuclear Materials and Equipment Corp., Apollo, Pa.); Thomas, I. D. ([Hanford Engineering Development Lab., Richland, Wash.]); Scott, J. L. (Oak Ridge National Lab., Tenn.); Shuck, A. B. (Argonne National Lab., Ill.). Sep 1971. 17p. (CONF-710901-49). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A continuing U. S. program for development and manufacture of high quality fast reactor fuel, pins and assemblies has produced significant advances in fuel and stainless steel component quality, reproducibility and reliability. Industrial suppliers are rapidly being qualified to produce cladding, fuel assembly ducts and mixed oxide fuel pins for LMFBRs with initial emphasis on FFTF driver fuel. Analytical and nondestructive testing capabilities and methods for fuel and other components have been improved. Fabrication costs are on a declining trend without concurrent decrease in quality. Reference process descriptions have been developed and tested, leading to issuance of a set of RDT Standards for FFTF driver fuel pins and components. Prototypic LMFBR fuel pin materials from development and qualification programs are being tested in as nearly prototypic LMFBR environments as possible. Excellent performance during fast reactor irradiation provides a growing confidence of predictable and reliable performance of FFTF driver fuel produced to RDT Standards. (J.R.D.)

37994 (ANL-7790) PREPARATION OF REPLICAS FOR ELECTRON MICROSCOPY OF IRRADIATED CERAMIC FUELS. Micheis, L. C.; Dragel, G. M. (Argonne National Lab., Ill.). Apr 1971. Contract W-31-109-eng-38. 10p. Dep. NTIS.

A technique for preparing replicas of irradiated uranium–plutonium dioxide nuclear fuel is described. Metallographically polished and etched specimens can be replicated by using a combination of in-cell and out-of-cell procedures. In addition, a technique is described whereby preselected, small, accurately locatable areas can be fractured and replicated. This latter technique is useful in determining fission-gas-bubble distributions as a function of radial position in the irradiated fuel. This technique was successfully applied to metallographic specimens from experimental mixed-oxide fuel elements irradiated in EBR-II. (auth)

37995 (BAW-3714-20) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 18, November 1970–January 1971. Carlson, R. V. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Apr 1971. Contract AT(30-1)-3714. 25p. Dep. NTIS.

The development of a sol-gel process and related processes for preparing $(U,Pu)O_2$ fast reactor fuels has continued at the Babcock & Wilcox Lynchburg Research Center. Progress for the 18th quarter, ending January 31, 1971, is reported. Eighteen fuel pins containing $^{235}UO_2$–20% PuO_2 in the form of pellets, shards, and sol-gel microspheres were shipped to the EBR-II for irradiation in an unencapsulated bundle. Fuel was fabricated and loaded in 16 additional pins during this quarter. Most of these will replace pins in the EBR-II bundle during scheduled outages. Nine capsules irradiated in the BAWTR were disassembled previously. Gas analyses and detailed metallographic examinations of the 27 fuel pins contained in these capsules are in progress in B&W's hot cell facilities. Photomicrographs of "as-ground" cross sections of sphere-pac and pellet pins exposed at 6, 10, 15, and 20 kW/ft are shown. (auth)

37996 TECHNOLOGY OF UO_2-/PuO_2-STAINLESS STEEL FUEL ELEMENTS. Foehl, C. A.; Nazare, S. (Institut fuer Material- und Festkoerperforschung, Karlsruhe, Ger.). Atomkernenergie; 17: No. 4, 245-50(Jul 1971). (In German).

Clad plate- and rod-type fuel elements of UO_2-/PuO_2-stainless steel-dispersions can be prepared by using picture-frame-technique, co-extrusion (5,6mm ϕ), swaging, or isostatic hot pressing. The relevant data of these methods are systematically evaluated. The influence of various parameters, e.g. degree of deformation,

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rolling temperature, extrusion pressure, and resistance to deformation is dealt with. A short summary of the testing methods is also included. (auth)

37997 PRODUCTION OF TECHNICAL GRADE ZrO_2 BY A CALCINATION–MAGNETIC PROCESS. Doronin, N. A.; Komarov, O. K.; Safronov, E. K.; Chistov, L. B. Tsvetn. Metal.; No. 2, 44-7(Feb 1971). (In Russian).

In the preparation of ZrO_2 by a novel process, the raw material was a baddeleyite–apatite concentrate, representing tailings from a preliminary magnetic separation of iron ore. A 40-minute calcination procedure at 900°C was followed by the main magnetic separation with clean-up. The non-magnetic fraction contained the refined ZrO_2. (K.S.W.)

37998 METHOD OF PREPARING FUEL PLATES FOR A NUCLEAR REACTOR. Handwerk, Joseph H.; Dusek, Joseph T.; White, George D. (to United States Atomic Energy Commission). U. S. Patent 3,576,925. 27 Apr 1971. Filed 2 May 1968.

A process for fabricating large numbers of thin, flat fuel plates for use in a nuclear reactor is given. A plurality of such fuel plates are hot pressed simultaneously in a single-cavity graphite die using graphite spacers between the plates. (auth)

37999 SOL-GEL PROCESSES FOR PREPARATION OF NUCLEAR FUELS. Hermans, M. E. A.; Kema, N. V. Jad. Energ.; 17: No. 6, 184-8(Jun 1971). (In Czech).

The advanced technology for preparation of nuclear fuel materials by the sol-gel technique which is especially suitable for preparation and/or recycling of fuel for both the high-temperature gas-cooled reactors (HTGR) and fast reactors is described. (auth)

38000 MANUFACTURE OF COMPOSITE REINFORCED ALLOYS. Sifferlen, Raymond; Guichard, Claude; Sorot, Jean-Claude (to Societe Industrielle de Combustible Nucleaire). French Patent 2,038,858. 28 Dec 1970. Filed 31 Mar 1969. (In French).

A composite alloy is described consisting of a base metal or alloy in which insoluble monocrystalline fibers or particles are dispersed. The particles or fibers are injected in a fluidized suspension or introduced by a preheated and inert gas, superficially sorbed or activated. The reinforcing materials are refractory compound particles or certain elements with large values for the elastic moduli: Al_2O_3, BeO, CaO, CeO_2, TiO_2, MgO, ThO_2, UO_2, ZrO_2, B_4C, HfC, NbC, SiC, TaC, TiC, WC, ZrC; AlN, BN, TaN, TiN, UN, ZrN; CeB_6, HfB_2, NbB_2, TaB_2, TiB_2, ZrB_2 and their compounds, and B, Be, C, Mo, W. Their size varies between 0.01 and 10 μm. The base metal may be Mg, Al, Fe, Ni, Cr or Co. (France)

38001 KINETICS OF SINTERING OF NIOBIUM CARBIDE BY HOT PRESSING IN THE HOMOGENEOUS REGION. Samsonov, G. V.; Petrykina, R. Ya.; Naumenko, V. Ya. (Inst. of Problems in Material Sciences, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 6: No. 12, 1863-5(Dec 1970).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: No. 12, 2123-5(Dec 1970).

The kinetics of sintering of niobium carbide by hot pressing in the homogeneous region at sintering temperatures of 2500, 2600, and 2700°C were studied. Phases with greater carbon deficiencies can be rendered relatively denser than virtually stoichiometric phases at the same temperature of sintering by hot pressing. The activation energy of sintering of niobium carbide by hot pressing in the homogeneous region has been determined; it increases with the carbon content of the carbide from 42 kcal/mole for $NbC_{0.5}$ to 88 kcal/mole for $NbC_{0.99}$. (auth)

38002 PREPARATION OF NIOBIUM CARBIDE BY REDUCTION OF $NbCl_5$ AND CCl_4 BY HYDROGEN. Petrusevich, I. V.; Nisel'son, L. A.; Chernukhin, Yu. A.; Kozlov, F. N. Inorg. Mater. (USSR) (Engl. Transl.); 6: No. 12, 1931-2(Dec 1970).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: No. 12, 2200-1(Dec 1970).

The kinetics of NbC production by reduction of $NbCl_5$ by hydrogen in presence of CCl_4 were studied. The relations between gas composition and carbide stoichiometry was studied. It was found that the reaction rate and yield with respect to Nb, decrease with the decrease of $NbCl_5$ concentration in the gaseous phase. (J.R.D.)

38003 VIBRATING BAR TECHNIQUE FOR PREPARING CARBON MICROSPHERES. Schmitt, C. R. (Union Carbide Corp., Oak Ridge, Tenn.). Nucl. Technol.; 11: No. 1, 29-37 (May 1971).

A process was developed for the preparation of dimensionally stable carbon microspheres from polyfurfuryl alcohol or other resins using a vibrating bar apparatus for spheroidization. The spheroidized particles (40 to 400 microns diameter) were prevented from coalescing by collecting them in mineral oil containing one percent surfactant where they remained in suspension until partially cured. After coking at 950°C in argon, the resin microspheres were converted to well-rounded carbon microspheres having an open porosity of 0.34 percent, a particle density of 1.62 g/cc, and a compressive strength as high as 19.5 pounds per particle for a diameter of 88 microns. (auth)

Properties Evaluations

Refer also to abstracts 37527, 37550, 37947, and 38587.

38004 (A/CONF.49/P–69) FUNDAMENTAL PROPERTIES AND BEHAVIOR OF FUEL MATERIALS IN FAST REACTOR ENVIRONMENTS. Rosen, S.; Simmons, J. M. (Division of Reactor Development and Technology (AEC), Washington, D. C.); Aitken, E. A. (General Electric Co., Pleasanton, Calif.); Frost, B. R. T.; Tevebaugh, A. D. (Argonne National Lab., Ill.); Sheely, W. F. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1971. 17p. (CONF-710901–40). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Research on fundamental properties of ceramic fuel materials is described with emphasis on these properties important to design of fuel elements and understanding fuel performance. Physical, mechanical, and thermodynamic properties and the effects of radiation on these properties are discussed. In addition, the behavior of fuel materials in fast reactor environments is detailed in regard to the chemistry and thermodynamics of the fuel, fission products, cladding and sodium coolant, and the interaction among these components. The experimental work is devoted primarily to mixed-oxide fuel although certain measurements on carbide fuels are included. Physical-property measurements reported include liquid-phase properties of oxides, such as surface tension, viscosity, compressibility, and density; and thermal expansion and conductivity as a function of stoichiometry and plutonium composition. Mechanical-property and related measurements directed toward elucidating the deformation processes in ceramic fuels, for example, in- and out-of-reactor creep of oxide fuel as functions of stress, temperature, composition, structure, and flux level, are presented. A fission-induced creep contribution is reported. Research that characterizes the ductile-to-brittle transition temperature and fracture characteristics of oxide fuels is described. Thermodynamic fuel properties obtained by transpiration, mass spectrometric, and effusion techniques are reported, namely, measurements on oxygen, plutonium, and uranium activities, partial vapor pressures, and the phase diagram for the U-Pu-O system. Measurements on carbide fuel systems are included. The chemical behavior of irradiated fuel revealed by out-of-pile and post-irradiation studies of fuel microstructures and fuel-cladding and fuel-coolant interactions is discussed. Particular emphasis is placed on the distribution of chemically reactive fission products and cladding components and also sodium-fuel reaction products. (L.C.L.)

38005 (ALO–2832–43) THERMAL INSULATION STUDY, PHASE II. Final Report, September 1967–September 1970. Grunert, W. E.; Morihara, H.; Notaro, F.; Webster, D. J.; Zawierucha, R. (Union Carbide Corp., [Indianapolis, Ind.] Linde Div.). May 1971. Contract AT(29-2)-2832. 371p. Dep. NTIS.

An AEC thermal insulation research and development program is described. The objective of this development program was to evaluate, develop where necessary and demonstrate thermal insulations for use in radioisotope power systems. The insulation systems investigated were multilayer type designed for operation in vacuum. The three major areas of effort included: flat plate thermal conductivity testing; long term performance stability; and the effects of interface on insulation thermal performance. Flat Plate testing was utilized to obtain experimental thermal conductivity data for several multi-layer insulations spanning service temperature ranges from 500 to 2500°F and layer density ranges corresponding to 0-15psi compressive loadings. Effective thermal conductivity in the lateral or longitudinal direction are also presented for several non foil multi-layer insulations. Empirical expressions were developed which can be utilized to compute thermal conductivity for the multi-layer systems tested at any temperature boundaries within its prescribed service range, and at any layer density corresponding to from 0 to 15 psi compressive loading. Several multi-layer insulation systems were evaluated to determine thermal performance stability over extended operating periods (2000 to 10,000 hours) at maximum service temperatures. Prior to the stability operating period, effective thermal conductivity data for the installed insulation configuration were determined at several different temperature levels. The effect of the presence

of a penetration through an insulation panel on the insulation thermal performance was determined for the case when the penetration and/or its immediate surroundings give rise to thermal discontinuities. Two types of penetration were investigated: flush penetrations and extended penetrations. For each of the two major types, zero gap, open gap and filled gap configurations are analyzed. The effect of exposed edges and gaps on thermal performance of various panel geometrics is evaluated with a two dimensional computerized analysis. Verification tests were performed on insulation panels with exposed edges. (auth)

38006 (ORNL–4704) ATMOSPHERIC CONTAMINATION OF URANIUM DIOXIDE POWDER. Smith, M. L.; Leitnaker, J. M. (Oak Ridge National Lab., Tenn.). Jun 1971. Contract W-7405-eng-26. 18p. Dep. NTIS.

Room-temperature contamination of UO_2 powder during storage in air of varying moisture contents for several hundred hours was studied. An initial rapid chemisorption of oxygen was followed by a slow and independent sorption of water and oxygen. Both the slow sorption rates are nonlinear in the logarithm of time. The effect of several oxidation and reduction cycles on the surface area of the UO_2 powder was also studied. Heating the UO_2 at 800°C decreased the surface area of the powder. Oxidation of the UO_2 to U_3O_8 at 400°C and reduction back to UO_2 at 500 to 700°C increased the surface area. (auth)

38007 (RD/B/N–1839) THE EFFECT OF THE CONDITION OF THE EXTERNAL SURFACE ON THE FRACTURE STRENGTH OF HTR FUEL COMPACTS. Tucker, M. O. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1971. 30p. (RPC(GP)/P–(70)46). Dep. NTIS (U. S. Sales Only).

With the use of existing linear elastic models, theoretical confirmation is given to the proposition that removal of the crack-free layer on the surface of an HTR fuel compact causes a reduction of approximately 30% in its fracture strength. The mechanism responsible for this effect is identified as the enhanced interaction between the compact surface and the circumferential cracks in the graphite matrix adjacent to the coated UO_2 fuel particles. The effect of the thickness of the crack-free surface layer on the fracture strength of the compact is also estimated. (auth) (UK)

38008 (RISO–223) DISPERSION-STRENGTHENED ALUMINIUM PRODUCTS. Manufacture, Structure and Mechanical Properties. Hansen, Niels (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar 1971. 151p. Dep. NTIS (U. S. Sales Only).

Dispersion-strengthened aluminum and aluminum oxide products were examined with a view to their nuclear application and in order to study the relationship between microstructure and mechanical properties. Products were examined as recrystallized, in the extruded condition and after cold drawing. Dispersion-strengthened aluminum products with mechanical properties comparable to those of SAP (sintered aluminum products) can be manufactured from blends of fine and unagglomerated aluminum and oxide powders. For low-oxide aluminum aluminum-oxide products (0.2 to 4.7 weight percent aluminum oxide), grain (subgrain)-boundary strengthening and oxide-dispersion strengthening are superimposed. The flow stress (0.2% offset) at room temperature for extruded, recrystallized and cold-drawn products is related to the grain size or subgrain size t by the equation $\sigma = \sigma_0 + kt^{-\frac{1}{2}}$ where σ_0 depends on the oxide content and k is a constant for each type of structure. The strengthening effect of grain boundaries and subgrain boundaries is the same as found in aluminum. The oxide-dispersion strengthening is in agreement with Orowan's model when the initial flow stresses at room temperature and at 400°C are considered. The strain-hardening rate at room temperature at small plastic strains (<3%) depends on the oxide phase parameters (volume fraction and particle size) as predicted in Ashby's work-hardening model. For great strains the strain-hardening rate is practically not affected by the presence of oxide. A three-dimensional network of aluminum–oxide particles strengthens aluminum effectively and almost to the same extent as a uniform dispersion of particles. A model for this network strengthening was proposed, based on the assumption of pile-up-aided Orowan bowing, and experimental evidence for the model was found. In extruded products manufactured from blends of atomized aluminum powder and oxide powder, the relationship between the flow stress (0.2% offset) and the particle size of the aluminum powder and the oxide content was satisfactorily explained on the basis of the network strengthening model. For SAP materials (7 to 14 weight percent aluminum oxide) it is likely, on the basis of the superposition principle, that oxide-dispersion strengthening depends on the oxide phase parameters and the strain, as found for the low-oxide products. (auth)

38009 (ORNL-tr–2443) MECHANICAL PROPERTIES AT HIGH TEMPERATURE OF CERAMICS BASED ON PLUTONIUM, APPLICATION TO FUEL ELEMENTS. de Novion, Charles; Lallement, Robert (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report CEA-CONF–1670, 13p, Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 11485.

38010 PROPERTIES OF UO_2–/PuO_2–STAINLESS STEEL-CERMETS. Nazare, S.; Ondracek, G. (Institut fuer Material- und Festkoerperforschung, Karlsruhe, Ger.). Atomkernenergie; 17: No. 4, 251-4(Jul 1971). (In German).

UO_2–/PuO_2–stainless steel-cermets can be considered to be a potential fuel for fast flux test reactors. For the optimal design of the fuel element some important properties need to be evaluated. The thermal and mechanical properties as functions of concentration and temperature are discussed. The present state of knowledge of irradiation behavior of these dispersions is also described. (auth)

38011 OUTGASSING OF NUCLEAR ROCKET FUEL ELEMENTS. Easton, D. S.; Clausing, R. E. (Oak Ridge National Lab., Tenn.). J. Vac. Sci. Technol.; 7: S116-23(Nov-Dec 1970). From 2nd International Vacuum Metallurgy Conference, Anaheim, Calif. See CONF–700640.

In order to predict the gaseous environment in a nuclear rocket engine before and after operation in space, an apparatus has been developed for measuring the type, quantity, and outgassing rates of gases that are released from graphite fuel elements at various temperatures in vacuum. Data readout from a quadrupole residual gas analyzer and nude Bayard–Alpert type ion gages permit analysis of up to 12 gases simultaneously. The data are processed by a computer program which first calculates the partial pressures of the various gases from a least square fit to a set of 18 simultaneous equations (one for each spectrometer peak) with 12 unknowns (12 separate gases). The coefficients of the unknowns are obtained from the cracking patterns of individual gases. The program then calculates and tabulates the outgassing rate of each gas for each sampling time and produces plots of the outgassing as functions of time or temperature. The computer program also: (a) fits the outgassing rates to an analytical expression, prints out the constants for the equation, and draws the best curve of the specified form through the data points; (b) extrapolates the data to long outgassing times and prints out the outgassing rates and total quantity of each gas at selected times; (c) compiles the data from a number of runs and plots the outgassing rates at preselected times as a function of temperature; and (d) prints out control data such as cracking patterns, calibration constants, and various checks and comparisons to aid in the evaluation of the instrumentation. The experiment not only produces accurate and detailed outgassing data, but also makes possible a more accurate extrapolation of data to long times and other temperatures. The detailed results will also aid in understanding the mechanisms controlling outgassing behavior. (auth)

38012 STUDY OF CERTAIN ELECTRIC PROPERTIES OF THE OXIDE SYSTEMS TiO_2–La_2O_3–B_2O_3, TiO_2–La_2O_3, TiO_2–B_2O_3. Codreanu, C.; Vancea, M. Stud. Univ. Babes-Bolyai, Ser. Phys.; 15: No. 2, 45-52(1970). (In Rumanian).

Some electric and mechanical properties are reported for the oxide systems: TiO_2–La_2O_3–B_2O_3, TiO_2–La_2O_3, and TiO_2–B_2O_3. A favorable effect is shown in the increase in the activation energy in the temperature range 900 to 1300°C for compositions that contain 3 to 5% (weight percent) of impurities in the base material. The system TiO_2–La_2O_3–B_2O_3 was obtained by the addition of LaB_6 to TiO_2. Its properties represent the superposition of the separate effects of La_2O_3 and B_2O_3, substances resulting from the oxidation of lanthanum boride above 750°. (tr-auth)

38013 TEMPERATURE DEPENDENCE OF THE SPECIFIC HEAT OF β-RHOMBOHEDRAL BORON. Bogdanov, V. I.; Vekilov, Yu. Kh.; Tsagareishvili, G. V.; Zhgenti, I. M. (Moscow Inst. of Steel and Alloys). Sov. Phys.-Solid State (Engl. Transl.); 12: No. 11, 2701-3(May 1971).

Translated from Fiz. Tverd. Tela; 12: No. 11, 3333-6(Nov 1970).

The specific heat of 99.9%-pure β-rhombohedral boron was measured at 16 to 280°K, and the temperature dependences of the Debye temperature and other thermodynamic functions are given. The Debye temperature had a singularity below 50°K. The influence of heavy impurities and phonons is discussed. (D.L.C.)

38014 SPECIFIC HEAT OF VANADIUM AND NIOBIUM CARBIDES AND THEIR ABSORPTION SPECTRA. Tskhai, V. A.;

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Mokronosov, V. S.; Chernyaev, V. S.; Gel'd, P. V. Zh. Neorg. Khim.; 16: No. 3, 611-16(Mar 1971). (In Russian).

The specific heat capacities of the various carbides of V and Nb were calculated from ir spectra of the respective compositions. Allowance was made for the contribution by Debye and Einsteinian frequencies. Extrapolation was made to 1300°K for VC_x and to 1800°K for NbC_x. Experimental data for these carbides were obtained for the temperature range 300 to 1300°K. (tr-auth)

38015 ISOCHRONAL ANNEALING KINETICS AND NEUTRON-INDUCED DIMENSIONAL CHANGES OF TITANIUM-DOPED PYROLYTIC CARBONS. Price, R. J.; Bokros, J. C. (Gulf General Atomic Inc., San Diego, Calif.). Carbon; 9: 205-18(Mar 1971).

A series of isochronal 1 hr anneals was conducted on a laminar pyrolytic carbon deposited at 1225°C containing 6.7 wt % Ti an isotropic pyrolytic carbon deposited at 2200°C containing 9.7 wt % Ti, and Ti-free companion carbons. Changes in layer spacing, apparent crystallite height (L_c), density, electrical resistivity, and microhardness were followed. Heterogeneous recrystallization to graphite started in Ti-doped isotropic carbon at 2300°C and was completed at 2500°C. The Ti-doped laminar carbon did not show catalytic recrystallization. The undoped isotropic carbon was not responsive to annealing. The Ti-doped and Ti-free laminar carbons showed a steady increase in L_c and density and a steady reduction in layer spacing and microhardness over a temperature range from 1400 to 2800°C, but significant reduction in electrical resistivity did not begin until ~1800°C. Dimensional changes induced by fast-neutron exposures up to $\sim 8 \times 10^{21}$ n/cm^2 at ~600 to 1250°C were measured and found to be lower by a factor of 3 to 10 in a catalytically graphitized pyrolytic carbon than in an as-deposited carbon with the same degree of preferred orientation. (auth) (UK)

38016 EXPLICIT SOLUTION FOR STRESSES IN PYROCARBON-COATED FUEL PARTICLES. Stevens, D. W. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Technol.: 10: No. 3, 301-6(Mar 1971).

An explicit solution for stresses and strains in pyrolytic-carbon coatings on spherical fuel particles is presented. The resulting model is a modification of the Prados–Scott model which accounts for stresses arising due to anisotropic, radiation-induced dimensional change, and the buildup of internal fission gas pressure and for stress relaxation due to radiation-induced creep. Finite displacements are shown to amplify the effects of anisotropic dimensional changes. The use of the explicit solution allows a reduction in computation time by several orders of magnitude. The reduction in computation time makes feasible the use of Monte Carlo analyses (which have previously been precluded by high computation costs) to establish the effects of random variations in coated-particle parameters. (auth)

Structure and Phase Studies

Refer also to abstracts 37541, 37975, and 38319.

38017 (IS-T-448) STUDY OF THE VANADIUM–OXYGEN SYSTEM. Alexander, David George (Ames Lab., Iowa). Jun 1971. Contract W-7405-eng-82. 58p. Dep. NTIS.

Thesis.

A phase diagram is proposed for the V–VO system based on melting point determinations, differential thermal analyses, metallographic observations, and x-ray parametric measurements. A eutectic reaction occurs at 1640°C and 11.4 wt % oxygen. The intermediate phases, V_3O and V_2O, form peritectoidally at 510° and 1185°C, respectively, while V_4O forms by a peritectic reaction at 1665°C. The VO phase melts congruently at 1790°C. The terminal solubility of oxygen in vanadium increases from 1.0 wt % at room temperature to a maximum of 6.0 wt % at the peritectic temperature. There is also extensive solid solubility associated with each of the intermediate phases. A martensite-like phase forms in alloys in the composition range 2 to 3 wt % oxygen upon quenching from above the 510°C peritectoid horizontal. (auth)

38018 RANGE OF EXISTENCE OF PEROVSKITE PHASES IN THE SYSTEM PbO–TiO_2–La_2O_3. Hennings, Detlev (Philips Forschungslaboratorium, Aachen). Mater. Res. Bull.; 6: 329-39(May 1971).

When lanthanum oxide is incorporated in lead titanate, lead oxide is eliminated and the formation of A-site vacancies predominates in the perovskite phase. Depending on the partial pressure, PbO can be taken up again from the vapor phase, and the A-site vacancies are converted into B-site vacancies. The range in which a perovskite phase can exist with A-site and B-site vacancies was investigated within the ternary system PbO–La_2O_3–TiO_2 by means of x-ray diffraction measurements, electron microprobe analysis, chemical analysis, and microscopic analysis. (auth)

38019 ELECTRON DIFFRACTION STUDY ON THE VAPORS OF TUNGSTEN TRIOXIDE. Hargittai, I. (Univ. of Texas, Austin. Center for Studies on Chemical Structures, Budapest); Hargittai, Magdolna; Spiridonov, V. P.; Erokhin, E. V. J. Mol. Struct.; 8: No. 1-2, 31-41(Apr 1971).

Electron diffraction patterns were recorded on the vapors of tungsten trioxide at about 1400°C. Of the 6 models, which were studied, the best agreement between experimental and calculated electron diffraction data was obtained for $(WO_3)_3$ species with a six-membered ring structure, although the presence of other polymeric species could not be ruled out. An average value of 1.77 ± 0.02 Å for the length of the tungsten–oxygen bonds was determined. (auth)

38020 VITROCERAMIC GLASSES OF THE SYSTEM Fe_2O_3–BaO–B_2O_3 HAVING MAGNETIC PROPERTIES. Solacolu, S.; Rusu, Ecaterina (Institut Polytechnique, Bucharest). Rev. Roum. Chim.; 16: 265-73(Feb 1971). (In French).

The limits of formation of glass in the system were established. The existence of the process of phase separation was established because of the tendency of the iron and boron ions to surround themselves each with four oxygen ions not arranged as bridges. These microphases are transformed by growing into stable nuclei. The magnetic properties of the vitroceramic masses obtained were determined. There was verified a dependence of the magnetic induction as a function of the magnitude of the external magnetic field, of the ferromagnetic nature, and of the contraction of the hysteresis curve according to the thermal treatment. (tr-auth)

38021 LUMINESCENCE AND PHASE STATE OF EUROPIUM OXIDE–TANTALUM OXIDE SYSTEMS. Kuznetsova, V. V.; Pinaeva, M. M.; Khomenko, V. E. Zh. Prikl. Spektrosk.; 13: 733-6(Oct 1970). (In Russian).

Data from x-ray, microstructural, and luminescence analyses were used for constructing a phase diagram of a Eu_2O_3–Ta_2O_5 system. Four phases, poly-, meta, ortho, and para-, of europium tantalate were determined. The luminescence spectra of specimens containing 33.3, 40.0, 42.9, and 50.0 mole% Eu_2O_3 were studied using a spectrograph with a photoelectric attachment. The data obtained was used in determining the optimum composition and preparation method for luminescent materials. (R.V.J.)

38022 STANDARD METHOD FOR MEASUREMENT OF LATTICE SPACING OF NUCLEAR GRAPHITE. ASTM C 558-69. Philadelphia; American Society for Testing and Materials (1969). 2p. Available from American Society for Testing and Materials, Philadelphia.

This method covers the measurement of the characteristic lattice space in the (00.l) and (110) crystallographic directions in nuclear graphite. (auth)

38023 PHASE BEHAVIORS AND CRYSTAL STRUCTURES OF THE ACTINIDE NITRIDES. Tagawa, Hiroaki (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 13: No. 5, 267-74(1971). (In Japanese).

The information available to date on the phase behaviors and the crystal structures of the actinides is reviewed. (auth)

38024 CONCERNING THE MELTING POINT OF GRAPHITE UP TO 90 KBAR. Fateeva, N. S.; Vereshchagin, L. F. (Inst. of High Pressures, Moscow). JETP Lett. (USSR) (Engl. Transl.): 13: No. 3, 110-11(5 Feb 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.: 13: No. 3, 157-9(5 Feb 1971).

The melting point of graphite was measured by an optical method, using Planck's radiation law. The melting curve had a maximum at 4900°K and 60 kbar, and its appearance suggests a triple point (diamond–graphite–liquid C) at lower temperatures and pressures (3600°K and 110 kbar) than that proposed by Bundy. (D.L.C.)

38025 EFFECTS OF A SHOCK WAVE ON GRAPHITE: ELECTRON MICRODIFFRACTION MICROSCOPY STUDIES. Fournier, Claire; Oberlin, Agnes (CNRS, Orleans-la-Source, France). Compt. Rend., Ser. B; 272: No. 17, 977-80(26 Apr 1971). (In French).

A compressed graphite pellet was subjected to a shock wave propagated perpendicular to its face. The pellet was then sliced parallel to the direction of the shock front. Electron-microscopy microdiffraction studies revealed four types of particles: diamond-type particles, intact graphite, graphite with high stacking disorder (stacking faults, rotation faults), and turbostratic carbon exhibiting the characteristics of hard carbon and incapable of being trans-

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formed into graphite by thermal treatment at 2500°C. The relative proportions of these particles in the various slices is different. (France)

38026 LIQUID IMMISCIBILITY IN OXIDE SYSTEMS. Levin, Ernest M. (National Bureau of Standards, Washington, D. C.). Refract. Mater.; 6: 143-236(1970).

Discussions of immiscibility in oxide systems are presented with emphasis on thermodynamics, phase equilibria, resolution of stable immiscibility, and metastable liquid immiscibility. (J.R.D.)

38027 RELATIONSHIPS BETWEEN PHASE DIAGRAMS AND THE STRUCTURE OF GLASS-FORMING OXIDE MELTS. Riebling, E. F. (Corning Glass Works, N. Y.). Refract. Mater.; 6: 253-70(1970).

Results of research are reviewed that indicate that the phase diagram (pressure-temperature for example) of a pure compound or composition can reveal structural similarities and dissimilarities between the various physical forms (crystalline polymorphs, liquid, glass) of that compound or composition. Until recently, any such conclusions about the similarity of melt and glass structures were based on either pure speculation or a rather scanty amount of high-temperature data. The phase diagram of a specified multicomponent system can show solid-state structural changes that are compositionally dependent. Examples include (1) the alteration or formation of polyhedral networks, (2) the change of coordination number for major cation species, and (3) macro and micro immiscibility phenomena. Recent liquid and glass physical-property studies for a variety of oxide systems show that these structure changes are not necessarily confined to the crystalline state. In some cases, such as the $B_2O_3 \cdot SiO_2$ system, the phase diagram may not completely reflect the structure changes that occur in the liquid state. However, for most of the binary systems considered the phase diagram appears to be a reasonable indicator of what to expect in the liquid state. Structural data for crystalline, liquid, or glass phases in one multicomponent system can be used to predict similar structural results for other systems that possess similar phase diagrams. This can be particularly important for predicting glass properties and structures for systems that exhibit marginal glass-forming tendencies. (auth)

38028 PHASE RELATIONS AND DILUTE MOLTEN SALT SOLUTIONS: THE CRYOSCOPIC APPROACH. Kozlowski, T. R. (Corning Glass Works, N. Y.). Refract. Mater.; 6: 271-307 (1970).

Research on dilute solutions near the liquidus of binary systems in general is reported. To accomplish this task, a review of the thermodynamics at the liquidus, and some of the phenomena ancillary to crystallization at the liquidus is presented. It has been noted that molten salts are indeed powerful solvents, not only for other salts but very often for oxides as well. The study of these systems continues with increasing use of cryoscopy as a supplemental tool for understanding reactions in the melt. A summary of the pertinent results of most of the studies discussed is given. The values of the heat or fusion (ΔH_f) must be considered as being only approximate since improved and more accurate studies are constantly being presented. (auth)

38029 INVESTIGATION OF NIOBIUM-RICH ALLOYS CONTAINING Zr AND B. Zakharov, A. M.; Novikov, I. I.; Pshokin, V. P. Izv. Akad. Nauk SSSR, Metal.; No. 2, 183-7(Mar-Apr 1971). (In Russian).

The system Nb–Zr–B (up to 8% Zr and 6% B) was studied by microscopy, and x-ray analysis, and solidus temperature determinations. Isothermal cross sections were constructed at 1950 and 1200°C. Polythermal sections were drawn for the Zr:B ratios = 8.4/1, 4.2/1, and 3/2, as well as for constant Zr content (2.5 and 8%), and constant B content (1%). The crystallization curve of the $\alpha + Nb_3B_2$ eutectic lies parallel to the Nb–Zr side at about 1.6 to 1.8% B. The addition of Zr (up to 8%) slightly lowers the Nb–B solidus from 2170 to 2050°C. Borides (Nb_3B_2 and (Nb, Zr)B) were found at 1200 to 1950°C which possessed tetragonal and rhombic lattices. Polythermal sections which issued from the Nb vontex of the ternary diagram were not quasi-binary, although one of them was in the region of the congruently melting boride ZrB_2. The borides Nb_3B_2 and (Nb,Zr)B possessed varying solubilities in solid Nb, decreasing at lower temperatures. In principle these phases could be used as hardening agents in Nb alloys during heat treatment. (tr-auth)

38030 PHASE TRANSFORMATIONS IN THIN FILMS OF ZrO_2–SiO_2 AND HfO_2–SiO_2. Ivanova, R. S.; Ignatov, D. V.; Lazarev, E. M. Zh. Neorg. Khim.; 16: No. 3, 846-9(Mar 1971). (In Russian).

Phase conversions in ZrO_2–SiO_2 and HfO_2–SiO_2 films were studied during heating in air to 1500°C. Electron diffraction patterns revealed that $ZrSiO_4$ and $HfSiO_4$ were formed above 1100°C. A metastable tetragonal modification of HfO_2 was found in the neighborhood of 1000°C. (tr-auth)

38031 X-RAY DIFFRACTION STUDY OF SOME BINARY OXIDES OF TANTALUM AND RARE EARTH ELEMENTS. Lykova, L. N.; Kovba, L. M. (Moscow State Univ.). Zh. Neorg. Khim.; 16: No. 3, 862-3(Mar 1971). (In Russian).

The preparation of tantalates was attempted with the composition $L_2O_3 \cdot n\ Ta_2O_5$, where L stands for La, Ce, Nd, Sm, Dy, Y, or Tm, and n = 5, 6, or 7. A study of the x-ray diffraction patterns suggested the presence of new modifications: $LaTa_5O_{14}$ and $CeTa_5O_{14}$. The other lanthanides characteristically formed a mixture of Ta_2O_5 and $LaTa_3O_9$. (K.S.W.)

38032 STOICHIOMETRY AND PHASE TRANSITIONS IN RARE EARTH OXIDES. Rudenko, V. S.; Boganov, A. G. (Inst. of Silicate Chemistry, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 6: No. 12, 1893-8(Dec 1970).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: No. 12, 2158-65(Dec 1970).

Phase transitions of rare earth sesquioxides involve reactions of the types $C\text{–}M_2O_{3+x} \rightarrow A\text{–}M_2O_3 + \frac{1}{2}xO_2$ (oxides of cerium and praseodymium) and $C\text{–}M_2O_{3-x}(OH)_{2x} \rightarrow A$ (or B)$\text{–}M_2O_3 + xH_2O$ (oxides of lanthanum, neodymium, samarium, europium, and gadolinium); consequently, the C forms of these oxides are phases with compositions differing from the sesquinoxide. The C → B transition of terbium oxide is also associated with a marked reduction reaction, but this already occurs at compositions below the sesquioxide: $C\text{–}M_2O_3 \rightarrow B\text{–}M_2O_{3-x} + \frac{1}{2}\ xO_2$. The high temperature of the phase equilibrium point (1850°C) explains the possibility of disproportionation of the composition in the reverse B → C transition, which renders the transition reversible in vacuum also. For the oxides of dysprosium, holmium, erbium, etc., the observed high-temperature transitions (above 2000°C) are reversible, like that of terbium oxide, at compositions below the sesquioxide. (auth)

38033 SYSTEM YTTRIUM–CHROMIUM–BORON. Kuz'ma, Yu. B.; Sobolev, A. S.; Furtak, M. P. (Lvov State Univ.). Inorg. Mater. (USSR) (Engl. Transl.); 6: No. 12, 1936-7(Dec 1970).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: No. 12, 2205-6(Dec 1970).

Phase equilibria and crystal structure of compounds formed by reactions among Y, Cr, and B at 800° were studied. The samples were prepared by annealing in vacuum-sealed quartz capsules for 300 hr. Data are included on atomic parameters and powder patterns for $YCrB_4$. (J.R.D.)

38034 EXAMINATION OF SYMMETRY OF ALPHA URANIUM TRIOXIDE. Siegel, S.; Hoekstra, H. R. (Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett.; 7: 497-504(Jun 1971).

The α-modification of UO_3 is one of seven known polymorphs, and methods for its preparation are outlined, as well as earlier work on its structure, in particular that of Zachariasen. From the studies described it is concluded that the structure is more complex than the configuration described by the small primitive cell assigned by Zachariasen. The powder patterns of α-UO_3 show slightly diffuse maxima and usually a set of very weak diffraction lines not related to the small cell. X-ray diffractometer tracings obtained under conditions of good resolution always show diffraction line asymmetry, characteristic of line structure, and this is considered to be the source of diffuseness in the powder pattern. Previous interpretations of the α-UO_3 infra-red spectrum are discussed (see J. Chem. Phys. 36: 1301 (1962)), and are considered to be open to question. Reference is also made to neutron diffraction studies. In order to resolve the α-UO_3 structure single crystals are required, and an attempt was made, with some success, to grow such crystals. Details are given of the crystallographic studies by the authors. Considering pseudoorthorhombic symmetry the parameters a = 5 × 3.949Å, b = 4 × 6.863A, and c = 4 × 4.161Å were obtained, but the possibility of some other symmetry as representative of α-UO_3 could not be excluded. The results, however, indicate that the symmetry is very close to hexagonal. Although the studies did not lead to a solution of the α-UO_3 structure problem, it is concluded that the available evidence from x-ray and neutron diffraction, density and infra-red data indicates that the α-UO_3 structure is more complex than the generally accepted simple hexagonal cell. (UK)

Radiation Effects

Refer also to abstracts 37528, 37529, 37992, 38551, 39166, and 39236.

38035 (RD/B/N-1851) GRAIN BOUNDARY ENERGY OF IRRADIATED URANIUM DIOXIDE. Reynolds, G. L. (Central

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Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1971. 9p. Dep. NTIS (U. S. Sales Only).

Specimens of irradiated UO_2 were fractured and examined. Annealing for 72 hr at 1600°C showed no alteration in pore geometry. Observations were made on intergranular gas bubbles. The ratio of grain boundary energy (γ_g) to surface energy (γ_s) was obtained by considering the equilibrium between grain boundary and bubble interfaces. The values of γ_g/γ_s obtained are between 1.8 and 1.6 with a median value of ~1.35. These high values are considered to be due to the contamination of the bubble surfaces by solid fission products. (UK)

38036 EFFECTS OF A LOW-TEMPERATURE IN-PILE IRRADIATION ON THE REFLECTING POWER AND THE REFLECTION PROFILE OF ALUMINA SINGLE CRYSTALS. Petry, Bernard; Pluchery, Max (CEN, Grenoble, France). Compt. Rend., Ser. B; 272: 240-2(18 Jan 1971). (In French).

The effect of neutron irradiation at 77°K on the reflecting power and reflection profile of single alumina crystals, was studied. An annealing at room temperature reduced the effect of a 2×10^{18} nvt dose to one quarter of its initial value. (auth) (France)

38037 INFLUENCE OF REACTOR IRRADIATION AND QUENCHING ON SILICON MICROHARDNESS AND MICROBRITTLENESS. Kirvalidze, I. D. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 62: No. 2, 297-300(May 1971). (In Russian).

It is shown that the microhardness and microbrittleness of silicon increases due to reactor irradiation and quenching (from 1,300°C to room temperature). (auth)

38038 EFFECT OF NEUTRON IRRADIATION ON THE DENSITY OF LiF CRYSTALS. Andreev, G. A.; Vasil'ev, G. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Inorg. Mater. (USSR) (Engl. Transl.); 6: No. 12, 1874-9(Dec 1970).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: No. 12, 2136-42(Dec 1970).

When LiF crystals with natural isotope ratio are irradiated in a reactor, 85 to 90% of the defects are due to neutrons. The influence of impurities on the accumulation of defects is felt at comparatively low doses (10^{15} neutrons/cm^2). The rate of accumulation of defects depends on the ratio of the rates of formation and radiation annealing of the defects. Alkali present as impurity in the crystal lattice increases the rate of accumulation and thermal stability of the defects, whereas magnesium as impurity reduces these quantities. In the irradiated crystals there is a set of defects with different thermal stabilities. Their annealing activation energy lies in the range 0.8 to 1.4 eV. (auth)

38039 COMPARATIVE STUDY ON THE WIGNER ENERGY OF BeO, MgO, Al_2O_3, AND VITREOUS SiO_2. Roux, Andre (Institut National des Sciences Appliquees, Villeurbanne, France); Cheippe, Jean; Elston, Jean; Gerard, Philippe. Compt. Rend., Ser. C; 272: 812-15(1 Mar 1971). (In French).

The results of a study on the stored energy in α-Al_2O_3 and in vitreous SiO_2 after fast neutron irradiation are presented. The radioinduced behavior of vitreous silica is quite different from that of the crystalline BeO, MgO, and Al_2O_3. (auth) (France)

Plastics and Other Materials

Refer also to abstracts 37413–37415, 37544, 37563, and 38560.

38040 (LFEN-NI-57a) RADIOLYTIC TREATMENT OF POPLAR WOOD. Alves, F. F.; Barbosa, M. R.; Mariano, M. H. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1970. 38p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

A method for improving the properties of poplar wood is described, based on the incorporation of a mixture of appropriate monomers, followed by its polymerization using γ radiation. It was verified that the treatment considerably improves some of the most important physical properties of the wood tested. (auth)

38041 PROCESS FOR MANUFACTURING A COMPOSITE MATERIAL. Thibault, Felicie Marie Laurence. French Patent 2,038,434. 28 Dec 1970. Filed 7 Mar 1969. (In French).

A method for manufacturing a multipurpose composite material is described. It may be used in building, sound insulation, thermal insulation, or radiation protection. A cellulosic material (wood for example) is powdered and mixed with a powdered metal such as Pb, Al, or B, and a conglomerating reagent consisting of natural or synthetic resin (aminoplastic resin, urea-formol, urea-melamine-formol, melamine-formol, phenol-formol, resorcine-formol, epoxide resin, acrylic resin, vinylic resin, etc.). All these components are conglomerated under pressure in a mold by heating. (France)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Cosmic Ray Exposure Ages

38042 (ORO–3585-22) STUDIES ON METEORITES. Final Report, October 1, 1966–September 30, 1970. Fisher, David E. (Miami Univ., Fla. Rosenstiel School of Marine and Atmospheric Sciences). Feb 1971. Contract AT(40-1)-3585. 9p. Dep. NTIS.

Several aspects of meteoritic research were investigated during the contract years. Particular results are briefly summarized. Geochemical investigations carried out are briefly described. A list of papers resulting from the contract is included. (W.D.M.)

38043 EVOLUTION OF THE KAPOETA HOWARDITE BASED ON FOSSIL TRACK STUDIES. Wilkening, Laurel; Lal, D.; Reid, Arch M. (Univ. of California, San Diego, La Jolla). Earth Planet. Sci. Lett.; 10: 334-40(Feb 1971).

A detailed study was made of the occurrence of high-particle-track densities in the gas-rich howardite, Kapoeta. In addition to the high-track-density pyroxene grains previously reported, feldspar grains were found with track densities and track density gradients identical with those in the pyroxenes. The spatial distribution of track-rich grains in the dark gas-rich portion of the meteorite is random. Grains that are track-rich are not a chemically distinct group; they show the same range of compositions as grains with normal track densities. The low-energy cosmic radiation that produced the high track densities and the enrichment in rare gases occurred during the extensive brecciation and mixing of Kapoeta parent materials. (auth)

38044 ABSOLUTE SCALE FOR RADIATION AGES OF STONY METEORITES. Herzog, G. F.; Anders, Edward (Univ. of Chicago). Geochim. Cosmochim. Acta; 35: No. 6, 605-11(Jun 1971).

Absolute production rates of ^{3}He and ^{21}Ne in average L chondrites were determined from a least-squares fit of noble gas to ^{26}Al data, for meteorites of age $< 2 \times 10^{6}$ yr in which ^{26}Al has not built up to saturation levels. The values obtained, 2.48 ± 0.23 and $0.466 \pm 0.031 \times 10^{-14}$ cc STP g^{-1} yr^{-1}, are 24% higher than conventional values, based on ^{3}H measurements. From this it appears that all published radiation ages of stony meteorites based on conventional production rates are too high by 24%. (auth) (UK)

38045 CHEMICAL CLASSIFICATION OF IRON METEORITES. V. GROUPS IIIC AND IIID AND OTHER IRONS WITH GERMANIUM CONCENTRATIONS BETWEEN 1 AND 25 PPM. Wasson, John T.; Schaudy, Rudolf (Univ. of California, Los Angeles). Icarus; 14: No. 1, 59-70(Feb 1971).

Concentrations of Ni, Ga, Ge, and Ir are reported for iron meteorites belonging to two small but definite chemical groups, and other irons with Ge contents between 1 and 25 ppM. These groups may be related to each other. Most other meteorites in this Ge concentration range are found to be unique in their chemical composition. One cluster of three irons (Gay Gulch, Garden Head, and Kofa) and two of two (Santa Catharina and Twin City, Cambria and Soroti) may be genetically related. (auth)

Stars

Refer also to abstracts 38410 and 38724.

38046 STABILITY OF NONRADIAL OSCILLATIONS OF COLD NONROTATING NEUTRON STARS. I. GENERAL METHOD. Battiston, L. (Univ., Padua. Scuola di Perfezionamento in Fisica, Padua); Cazzola, P.; Lucaroni, L. Nuovo Cim., 3B: No. 2, 295-318(11 Jun 1971).

A general method for analyzing the stability of equilibrium configurations of cold nonrotating fully relativistic neutron stars for nonradial modes of oscillation is outlined, on the assumption that the star is made of a perfect fluid. A suitable frame of reference is chosen such that Einstein's linearized equations for the oscillation turn out to be fairly simple. The four independent solutions of these equations can be interpreted as amplitudes describing ingoing and outgoing sound and gravitational waves coupled together. Approximate solutions are constructed such as to obey the asymptotic requirements for $r \to 0$, $r \to \infty$, r being the distance from the center of the star, and for $\omega \to \infty$, ω being the oscillation frequency. The study of proper (complex) frequencies ω_n (for outgoing waves) of the star is reduced to the study of the zeros of a definite entire function $\Delta(\omega)$ which is constructed with the obtained approximate solutions. (auth)

38047 CAUSE OF THE NOVA OUTBURST. Starrfield, Sumner (Yale Univ., New Haven). Mon. Notic. Roy. Astron. Soc.; 152: No. 3, 307-22(1971).

Observational studies of old novae have shown that they are close binaries with one of the components a white dwarf accreting hydrogen-rich material from the other component. To determine if the nova outburst could be caused by a thermal runaway in the envelope of the white dwarf, a computer code designed to take short time steps was used to compute evolutionary sequences for helium-rich white dwarfs with hydrogen-rich envelopes. None of those computed using initial conditions derived from the observations of DQ Her had significant thermal runaways or produced the 10^{45} erg observed in the outburst of DQ Her. An evolutionary sequence was then computed which used initial conditions that included the effects of an accretion shock (Starrfield 1970). A thermal runaway resulted which produced the energy observed in the outburst of DQ Her. Two evolutionary sequences were computed with a mass of 0.5 $M_{\odot}$. A thermal runaway occurred in each sequence and produced more than 10^{45} erg. In these models, as the peak of the runaway was reached, the shell source compressed and heated the outer layers of the helium core until helium burning was initiated. (auth) (UK)

38048 POSSIBLE UPPER LIMIT TO THE DISTANCE OF BL LACERTAE. Stein, W. A. (Univ. of California, San Diego, Univ. of Minnesota, Minneapolis); Gillett, F. C.; Knacke, R. F. Nature (London); 231: No. 5300, 254-5(28 May 1971).

It is stated that apart from indications that the spectrum of BL Lac is that of synchrotron radiation from nonthermal electrons, little is known about this object, and there are no spectral lines from which the usual astronomical analyses might be made, one consequence of which is that even the distance to the source is unknown. The purpose of the present analysis is to estimate an upper limit. Observations were made on the nights of Aug. 25 and 27, 1970. Two interesting features were: (1) the nonthermal spectrum flattened with decreasing frequency in such a way that most of the energy appeared to be concentrated towards the region around λ = 3 μm, and (2) there was an obvious discontinuity between λ = 2.2 and 3.5 μm. It was therefore concluded that the source is varying not only at radio and visual wavelengths, but also in the infrared. An equation derived suggests that an upper limit to the distance can be estimated, provided that upper limits can be determined for the size of the source, R, and for the magnetic field, B. An upper limit on R can be set from the time scale of the observed variations, and methods are indicated for setting limits to the magnetic field; these are concerned with considerations of synchrotron self-absorption and with the lifetime of radiating electrons. From the observations the distance implied for BL Lac is <1 Mpc, with sizes $< 10^{17}$ cm at radiofrequencies and $< 3 \times 10^{15}$ cm at visual and infrared. The possibility that the discussion is not valid, however, because of relativistic expansion in the source must be considered. (UK)

38049 INFRARED SPECTRA OF STARS, 1 TO 2.5 μ. Smyth, M. J. (Univ. of Edinburgh); Cork, G. M. W.; Harris, J.; Wallace, T. Nature (London) Phys. Sci.; 231: No. 22, 104-5(31 May 1971).

The spectra reported with the 190-cm telescope of the Radcliffe Observatory, Pretoria, are believed to be the first infrared spectra of stars at wavelengths substantially beyond 1 μm obtained in the Southern Hemisphere. This instrument is an interferometer spectrometer, with an ultimate resolution of 0.5 cm^{-1}, employing the rapid-scan principle, and allows the scintillation frequencies due to atmospheric turbulence to be filtered out. Signals are recorded by an analogue magnetic tape recorder. Examples of stellar spectra at 8 cm^{-1} resolution are shown; the CO bands commencing at 4,360 cm^{-1} are the most prominent features. (UK)

38050 RELATIVISTIC STELLAR WIND THEORY: NEAR ZONE SOLUTIONS. Henriksen, R. N.; Rayburn, D. R. (Queen's Univ., Kingston, Ont.). Mon. Notic. Roy. Astron. Soc.; 152: No. 3, 323-32(1971).

The topology of possible solutions to the relativistic stellar wind problem is considered. These solutions include that of Michel, consisting of a stellar wind that becomes asymptotically relativistic only at infinity. There is also a set of solutions corresponding to the classical solar "breeze." The latter solutions have hitherto been overlooked in the literature. It is shown that they are truly relativistic solutions. They are compared to a mechanical analogy consisting of a bead free to move on a rigid massless wire rotating about a perpendicular axis through one end. A criterion is given for deciding the relevant type of solu-

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tion in terms of the angular momentum and energy fluxes at a star. (auth) (UK)

38051 HD 152667, A SPECTROSCOPIC BINARY P CYGNI STAR. Walker, E. N. (Royal Greenwich Observatory, Eng.). Mon. Notic. Roy. Astron. Soc.; 152: No. 3, 333-40(1971).

The spectroscopic binary P Cygni star, HD 152667, was the subject of a radial velocity investigation. It was found to have a 7.84825-day period. Only one spectrum was visible, but both primary and secondary eclipses have been observed at the Cape Observatory. The primary is a Bolae star. The material that causes the emission profiles was found to be associated with the primary component and to have a redshifted radial velocity of approximately 300 km s^{-1} compared with the primary star. There was evidence for intrinsic radial velocity variations superimposed on the orbital motion of the star. It is possible that these intrinsic variations are a periodic phenomenon. The star is near to the cluster NGC 6231 in the sky and is possibly a member of this cluster. (auth) (UK)

38052 HYDRODYNAMICS OF A HELIUM-SHELL FLASH IN A STAR OF ONE SOLAR MASS. Zimmermann, Rolf Erik. Los Angeles; Univ. of California (1970). 123p. University Microfilms Order No. 71-10,655.

Thesis.

The evolution of a metal-poor star of one solar mass was calculated from the main sequence to the helium flash under the assumption that the plasma neutrino and photoneutrino processes act to cool the center during the giant phases. The helium flash occurs in a shell 0.24 of the way (in mass) from the center to the surface of the star. At the peak of the flash, the energy production rate from helium burning is 5×10^9 solar luminosities. It is shown that the assumption of adiabatic convection probably remains valid throughout the flash. The hydrodynamic evolution near the peak of the helium flash was calculated with a hydrodynamic computer code based on the Henyey method. The results indicated that no explosion takes place in the core of the star, and that no core explosion is likely even for a flash one or two orders of magnitude more intense. Some estimates were made as to the probable hydrodynamic developments in the envelope of the star. It was demonstrated by means of a test calculation that if convection is less efficient than would be expected from the usual adiabatic approximation, a more violent flash will be the result. Energy generation from the $^{14}N(\alpha,\gamma)^{18}F(\beta^+\nu)^{18}O$ reaction was included in the calculations so that the effect of a recent revision in cross section could be tested. It was found that this reaction makes only a negligible contribution to the total energy generation during the helium-burning phases of evolution. (Diss. Abstr. Int., B)

38053 HIGH-RESOLUTION OBSERVATION OF STELLAR AND INTERSTELLAR LITHIUM. Utiger, Herman Edward. Madison, Wis.; Univ. of Wisconsin (1971). 137p. University Microfilms Order No. 71-5667.

Thesis.

High-resolution optical measurements were taken of the lithium content of two K giant stars and in the interstellar regions of Cygnus and Orionus using a PEPSIOS spectrometer at the Kitt Peak National Observatory's 84" telescope. The lithium abundance of these stars had previously been measured by Bonsack, however, due to recent solar lithium measurements it was felt that molecular lines were interfering with the measurements. Lithium resonance lines near 6708Å were identified from their splitting, intensity ratio, and wave number. The wave number scale was established using molecular lines in the lithium region. New upper limits were established on the stellar lithium abundances which were down to one-tenth those previously thought. New upper limits were established on the interstellar lithium abundances in the cloud complexes in front of ϵ Ori and α Cyg. There were no absorption lines observed anywhere within the scans and, in particular, there were no observable lines at the position of the heliocentric velocities of the interstellar sodium clouds. The upper limits on the interstellar abundances are such that, if lithium were present with a meteoric abundance, the experiment should have detected the lithium. These upper limits for interstellar lithium are about ten times less than previously established. (Diss. Abstr. Int., B)

38054 HYDROGEN-DEFICIENT MODEL ATMOSPHERES FOR DEGENERATE STARS. Doyle, Robert John. Charlottesville, Va.; Univ. of Virginia (1970). 134p. University Microfilms Order No. 71-6622.

Thesis.

A preliminary model atmosphere analysis was applied to two types of degenerate stars that have cool hydrogen-deficient atmospheres. (TSS) (Diss. Abstr. Int., B)

38055 BETA CANIS MAJORIS STARS: A BINARY HYPOTHESIS. Seeds, Michael August. Bloomington, Ind.; Indiana Univ. (1970). 272p. University Microfilms Order No. 71-13,558.

Thesis.

The Beta Canis Majoris (BCMa) stars are irregular, short-period, variable stars at least ten times more massive than the Sun. Normal stars of this mass are stable. What, then, makes the BCMa stars irregular variables? Until recently this problem has remained unsolved. In the last year, however, evidence has been found that these stars are not single intrinsic variables, but close binary systems. This revolutionary hypothesis can account for many of the observed features of the BCMa stars. The subject of this thesis is a re-examination of the knowledge of the BCMa stars in light of the suspicion that they are binary systems, and a report of an observational test of the binary hypothesis. Examination of published material revealed no discrepant data. Each characteristic of these stars can be accounted for by the tidal distortion of a pulsating star. The periodic variation of the aspect of the tidal bulge can produce variations in the mean light level and the shape of the light curves. Rough models of mass exchange between close binaries were calculated to demonstrate that such a process could have deposited an envelope of heavy material on the secondary of the system. It is shown that this star could become a pulsating star which, due to the tidal effects of its small companion, would behave as a BCMa star. A differential photometer and the associated data handling system were designed to obtain accurate, rapid, equally spaced observations of some of these stars. The observations were analyzed by numerical filtering and by power spectrum analysis. No evidence for the suspected ringing in the light curves was found, but the bumps present on the light curves were found to be strongly dependent on the pulsational phase of the stars, occurring most frequently on the falling and rising branches of the curves. In addition, the bumps on the light curves of Spica show a dependence on the orbital phase of the system. This is also true of 12 Lacertae, but to a lesser degree. These bumps evidently are an integral part of the pulsation of the star and are only modified by the tides. The binary hypothesis is acceptable and deserves further study. It can account for all of the presently observed characteristics of the BCMa stars. (Diss. Abstr. Int., B)

38056 TWO-COLOR PHOTOMETRIC METHOD FOR DETECTION OF EXTRA-SOLAR PLANETARY SYSTEMS. Rosenblatt, Frank (Cornell Univ., Ithaca, N. Y.). Icarus; 14: No. 1, 71-93(Feb 1971).

The transit of a star by a dark companion or planet results in a characteristic colorimetric "signature," which should be detectable by photometric means. This signature, which is due to differential limb darkening in red and blue light, takes the form of a slight shift towards the blue as the planet crosses the limb of the star, followed by an abnormal reddening during the transit of the center region of the star, and finally another shift towards the blue as the planet approaches the far limb. An analysis of this signature, the probabilities of detecting such transits (using the solar system as a model), and possible instrumentation for this purpose are discussed. A system designed to yield one or more planetary detections per year is believed to be feasible at moderate cost. Such a system would consist of three wide-field telescopes, at well-separated sites, slaved to a central computer. Each telescope would be equipped with a two-color photometer employing an image dissector under computer control for tracking and rapid switching between program stars without requiring resetting of the instrument. Each telescope would survey an independent sample of stars on a rapid rotation cycle, until one of the telescopes detected an unusual transient, at which time all three would be used to provide additional data and increased reliability as a coincidence detection system. (auth)

38057 QUADRATIC ZEEMAN SHIFT IN WHITE DWARFS. Trimble, V. (Cambridge Univ., Eng.). Nature (London) Phys. Sci.; 231: No. 23, 124(7 Jun 1971).

It has been pointed out that it should be possible to determine, or set upper limits to, magnetic fields in the range 10^5 to 10^6 G in DA white dwarfs from the quadratic Zeeman shifts of their H Balmer lines, and a limit of 5×10^5 G was suggested for DA stars generally from radial velocity data (Preston, Astrophys. J., 160: L143(1970)). It is considered however, that this limit was rather more stringent than the data justified, since discordant higher Balmer lines had been systematically excluded in finding mean velocities for the stars. For this reason it seemed worthwhile to examine the individual line velocities for a number of stars and to attempt to fit magnetic fields to them, and such an analysis is described. (UK)

38058 PHOTOMETRY AND STRUCTURE OF THE YOUNG OPEN CLUSTER NGC 7380. Moffat, A. F. J. (Ruhr-Univ., Bochum, Ger.). Astron. Astrophys.; 13: No. 1, 30-9(Jun 1971).

An extensive investigation of NGC 7380 was made using photographic UBV photometry. The program contains all stars for which V ≦ 16.35m within a circle of 31′ diameter surrounding NGC 7380. A distance of (3.6 ± 0.7 max error) kpc and an age of 2×10^6 years were derived. Extinction of early-type members and projected star density counts indicated that NGC 7380 is surrounded by two dust shells at central radius r ≅ 6.5′ and r ≅ 10.4′ with a possible third one at r > 13′. The dust mass of the innermost shell is large (~50 $M_\odot$) compared to the H II mass (2000 $M_\odot$: Schwartz, 1970—here revised with new distance) and the stellar mass (440 $M_\odot$: lower limit). A deficit of faint stars in the central region (r < 3′) was observed. This may be due to mass-dependent interruption of star formation by H II. A connection of the deficit and the dust shells with the association Cep OB 1 was not established. (auth)

38059 MAGNETIC STARS AS GENERATORS OF COSMIC RAYS. Havnes, Ove (Astronomical Inst., Utrecht). Astron. Astrophys.; 13: No. 1, 52-7(Jun 1971).

A process is suggested in which interstellar gas particles can be accelerated by the electromagnetic forces produced by a rotating stellar magnetic field. The element to be accelerated should be ionized when it encounters the magnetic field of the star. The observed abundances of the different elements in the low-energy range is naturally explained in terms of differences in the degree of ionization prior to acceleration and by the corresponding difference in probability of acceleration. On the assumption that all the rotational energy of the magnetic stars is finally converted into acceleration of interstellar ions, the energy input by this process may be in excess of 10^{-27} erg cm^{-3} s^{-1}. It is suggested that such a cosmic-ray source, from which the energy input may be of the order of a few percent of the energy input required to explain the total spectrum of cosmic rays, is of importance in the low-energy part of the spectrum. (auth)

38060 REALITY OF THE STELLAR RING IN AQUILA. Prochazka, P. V. (Vienna Univ. Observatory). Astron. Astrophys.; 13: No. 1, 71-8(Jun 1971).

Isserstedt (1968, 1969) used proper motions from the General Catalogue (Boss, 1937) to support the reality of the stellar ring in Aquila. In the present work, new catalogues were used in addition to the GC to derive better proper motions. All the available catalogues were reduced to the system of the GC and then to the FK 4. The proper motions were derived numerically, with a mean centennial error of about 0.6″. It is shown that there are arguments for the reality of the Aquila Ring, but also that the proper motion dispersion of the ring stars is still too great. (auth)

38061 RELATIVE EXCITATION FUNCTIONS FOR ELECTRON IMPACT WITH MAGNESIUM. Karstensen, F.; Koester, H. (Univ., Kiel). Astron. Astrophys.; 13: No. 1, 116-18(Jun 1971).

By a crossed-beam experiment relative excitation functions for electron impact processes $Mg + e \rightarrow Mg^{+*} + e + e$ were measured. The intensities of the emitted lines were observed. Cascading effects were taken into account. (auth)

38062 STARS WITH CENTRAL HELIUM BURNING AND THE OCCURRENCE OF LOOPS IN THE H–R DIAGRAM. II. SECULAR INSTABILITIES DURING THE LOOPS. Lauterborn, D.; Refsdal, S.; Roth, M. L. (Univ. of Oslo). Astron. Astrophys.; 13: No. 1, 119-29(Jun 1971).

The central He-burning phases of stars with 7 and 9 $M_\odot$ were investigated. In some cases secular instabilities occur during the loops, particularly when the mass of the star is high and when the ratio of mixing length to pressure scale-height (l/H_p) is low. Due to this effect, the time a star ($M \gtrsim 6\ M_\odot$) needs to cross the Cepheid strip can, in some cases, increase considerably when l/H_p is increased, so that the expected number of Cepheids with long periods will increase with increasing l/H_p. (auth)

38063 SPACE DISTRIBUTION AND AGES OF Ap AND Am STARS. Renson, P. (Univ., Liege). Astron. Astrophys.; 13: No. 1, 130-5(Jun 1971). (In French).

The space distribution of the stars known to be Ap or Am is rather similar to that of other B- and A-type stars; most differences seem explainable by observational-selection effects. The proportion is high in some clusters: the Hyades, Praesepe, Coma Berenices (⅓ of Trumpler's physical members of this cluster are Ap or Am stars); it is high also in the whole Hyades group and in the Sirius group. Ap stars are present in clusters, groups, and associations having ages from some million to nearly one billion years, with a maximum for ages of the order of ten million years; for the Am stars, the greatest proportion is only reached for several hundred million years. In the mean, Ap stars are younger and Am stars older, the ratio of the numbers of stars for these two categories decreasing with the age of the clusters. The proportion of Ap or Am stars seems to vary from one cluster to another, even for similar ages. It is particularly low in the Pleiades and the α Per cluster where, also, short-period binaries have been found to be rather scarce. (auth)

38064 EFFECT OF UNIFORM STELLAR ROTATION ON ABSORPTION LINE STRENGTHS AND ABUNDANCES. Vilhu, Osmi; Tuominen, Ilkka V. (Univ. of Helsinki). Astron. Astrophys.; 13: No. 1, 136-46(Jun 1971).

Theoretical results on the effect of uniform rotation on the equivalent widths of metallic lines for main-sequence stars are presented. Most calculations made are for pole-on stars, because even reasonably strong lines will be washed out at quite small inclinations. Also, because uniform rotation does not greatly change the mean atmospheric parameters for pole-on stars, the changes in the equivalent widths may result in errors in abundance. The effect is small for Mg II 4481, Si II 4128, and O I 8446 but significant for the Ca II K-line. Fe II and Cr II lines will be amplified in a similar manner, and larger Fe I/Fe II ratios are a result of rotation. Sr II and Eu II type lines will be amplified most and an error of one power of ten in their abundance is possible in spite of the saturation in cooler equatorial regions. Microturbulent velocity has great influence on the magnitude of this phenomenon. The effects will also strongly depend on the mass of the star. The results can possibly be used to separate slow rotators and fast pole-on rotators in late B- and early A-type stars, as well as to consider the validity of the assumption of uniform rotation. (auth)

38065 NUCLEOSYNTHESIS DURING ^{4}He BURNING. Vidal, N. V.; Shaviv, G.; Kozlovsky, B. Z. (Tel Aviv Univ., Israel). Astron. Astrophys.; 13: No. 1, 147-51(Jun 1971).

New information on reaction rates enables a reduction in the uncertainties of ^{12}C, ^{16}O, ^{20}Ne, and ^{24}Mg abundances during ^{4}He burning. The most important result is that ^{20}Ne is a major product in massive stars. (auth)

38066 SEMI-CLASSICAL CALCULATIONS OF ELECTRON AND ION COLLISIONAL BROADENING OF THE STRONGEST UV IONIC LINES OF ASTROPHYSICAL INTEREST. Sahal-Brechot, S.; Segre, E. R. A. (Observatoire de P a r is , Meudon, France). Astron. Astrophys ; 13: No. 1, 161-8(Jun 1971).

The electron and ion damping constants of the strongest ionic uv lines of astrophysical interest (CII/III/IV, N II/III/V, O VI, Si II/III IV, and S III/IV/VI) were calculated within the impact and semi-classical approximations and compared to experiments when they are available (N II (1) and C II (1)). (auth)

38067 CONTINUOUS ENERGY DISTRIBUTION FROM STARS WITH HOT EXTENDED ATMOSPHERES. Cassinelli, Joseph P. (Univ. of Colorado, Boulder). Astrophys. Lett.; 8: No. 3, 105–9 (May 1971).

The continuous energy distribution of the emergent flux for five extended model atmospheres is tabulated, and the color temperatures at optical wavelengths are computed. The wavelength dependence of the color temperature is found to be similar to that observed in the continua of Wolf–Rayet stars. It is shown that a hot star with a very extended atmosphere has an optical continuum surprisingly similar to that of a star with a cooler less-extended atmosphere. Observations to test the dependence of the continuum on geometrical extension are outlined. (auth)

38068 DEPENDENCE OF THE RATE OF STAR FORMATION UPON GAS DENSITY. Talbot, Raymond J. Jr. (Rice Univ., Houston, Tex.). Astrophys. Lett.; 8: No. 3, 111-14(May 1971).

It is shown that previous analyses of the correlations between young stars and gas in external galaxies are incapable of ascertaining κ in the relation stellar birth rate $\propto \rho_g^{\kappa}$, where ρ_g is the neutral hydrogen gas density. Adequate analyses require detailed calculations involving specific models of the mass distribution in the galaxies, as well as assumptions about the birth-rate function. (auth)

38069 ZEEMAN SPLITTING OF THE 21-cm ABSORPTION LINE IN ORION A. Brooks, J. W.; Murray, J. D.; Radhakrishnan, V. (CSIRO, Sydney). Astrophys. Lett.; 8: No. 3, 121-3(May 1971).

Measurements of the 21-cm absorption line in the spectrum of Orion A were made in June 1970 to detect Zeeman splitting effects. A magnetic field of the order of 50 μG was found, in agreement with earlier determinations by Verschuur. (auth)

38070 ANGULAR MOMENTUM TRANSPORT IN STARS, FOLLOWING THE GOLDREICH–SCHUBERT INSTABILITY. James, R. A.; Kahn, F. D. (Univ. of Manchester, Eng.). Astron. Astrophys.; 12: No. 3, 332-9(Jun 1971).

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The nonlinear development of the Goldreich–Schubert instability leads to a terminal state in which any isentropic surface is partitioned between regions of constant $\mathcal{K}$ ($\mathcal{K}$ domains) and regions of constant Ω (Ω domains). The sliding instability controls the $\mathcal{K}$ domains, and shear instabilities control the Ω-domains. The boundaries between these domains are narrow and variable. An enhanced Eddington–Sweet current flows in the boundary regions, and the resulting mean flux of angular momentum is calculated. In most circumstances, this flux is of the same order as the normal Eddington–Sweet flux, and the appropriate time scale for large-scale redistribution of angular momentum is therefore the Eddington–Sweet time scale. (auth)

33071 INFLUENCE OF VECTOR COUPLING SYSTEM ON THE CONTINUOUS ABSORPTION COEFFICIENTS. Kriener, H. Astron. Astrophys.; 12: No. 3, 363-70(Jun 1971). (In German).

Atomic photoionization cross sections and continuous absorption coefficients of the elements C I, Si I, and Ge I were calculated under LS-, LK-, JK- and jj-coupling systems. Considered were dipole transitions of a single electron moving in a central field. The transition matrix elements were determined using the quantum defect method of Seaton and the Racah method of tensor operators. Initial and final states are described by the same coupling scheme. The following results were obtained: (1) The photoionization cross sections depend on coupling systems. For some levels the cross sections vary considerably from one coupling system to another. (2) The continuous absorption coefficients were calculated in the spectral region from 2,000 to 10,000 Å for temperatures from 8,000°K, 10,000°K, ..., 16,000°K. The results of numerical calculations are summarized. No dependence was found on the coupling system for C I and Si I. For Ge I the absorption coefficients varied from one coupling system to another in the spectral region from 2000 to 2200 Å. (auth)

38072 LINE BROADENING IN γ EQUULEI. Evans, J. C.; Elste, G. (Univ. of Michigan, Ann Arbor). Astron. Astrophys.; 12: No. 3, 428-34(Jun 1971).

Weak and medium strong iron lines in γ Equ were used to show that velocities of 3 km/s exist in the photosphere. The profiles of the sharpest lines, which are more triangular than bell-shaped, and the curve-of-growth indicated only small effects from microturbulence; the major influences on the profile are macroturbulence and rotation. As can be expected for a magnetic star, most lines are broadened by unresolved Zeeman patterns. This is concluded from a comparison of observed with theoretical line profiles formed in an LTE model atmosphere ($\theta_{eff} = 0.654$, log g = 3.5, solar abundances) under the presence of a transverse Zeeman effect for field strengths in excess of 2000 G. Although it is possible to recognize Zeeman broadening as distinct from other broadening mechanisms it may be physically unrealistic to expect a unique field strength for all sorts of lines in the spectrum. (auth)

38073 TRANSFER OF PHOTOMETRIC SYSTEMS. Moreno, H. (Univ. de Chile, Santiago). Astron. Astrophys.; 12: No. 3, 442-51(Jun 1971).

UBVR photoelectric observations of 81 stars are used to analyze the problems of transfer of photometric systems from the northern to the southern hemisphere or vice versa. The observations were made at Lick Observatory and the reductions were performed following the conventional method and a refined method. A comparison of the results and of the accuracy obtained by both methods is given. (auth)

38074 ELLIPTICAL POLARIZATION MEASUREMENTS NEAR 30 DORADUS AND η CARINAE. Schmidt, Th. (Max-Planck-Institut fuer Astronomie and Landesternwarte, Heidelberg). Astron. Astrophys.; 12: No. 3, 456-63(Jun 1971).

Elliptical surface polarization of the optical radiation within the diffuse nebulae around 30 Doradus and η Carinae was measured at the Boyden Observatory, South Africa, using a 50-cm reflector and a digital photoelectric elliptical polarimeter. The outputs of five pulse counters are directly proportional to the Stokes' parameters I, Q, U, and two different components of V. The results are shown. Circular polarized light components are indicated in three fields with chaotic structure and apparent obscuration. Within both nebulae significant deviations occur between surface polarization angles and the fairly uniform star light polarization. In case of 30 Dor this is explainable by stray light polarization tangentially orientated with respect to the nebula center; for η Car a second aligned dust layer connected with the nebula itself is indicated. (auth)

38075 BALMER-LINE VARIABILITY OF BETA CARINAE. Wood, H. John (European Southern Observatory, Santiago, Chile); Hollis, J. M. Astron. Astrophys.; 12: No. 3, 468-73 (Jun 1971).

Repeated photoelectric spectrum scans of the profile of the Balmer line Hβ in the spectrum of Beta Carinae show a quasi-periodic oscillation in the line strength. Flare generated acoustic oscillations of the stellar atmosphere may cause the Balmer-line variations reported. (auth)

38076 FOUR NEW STAR CLUSTERS IN THE DIRECTION OF THE CENTRAL AREA OF THE GALAXY. Terzan, A. (Observatoire, Lyon). Astron. Astrophys.; 12: No. 3, 477-81 (Jun 1971). (In French).

Four new clusters (Terzan 9–12) were detected in the direction of the central area of the Galaxy. The photographic observations R ($\lambda_{eff} \cong 6400$ Å) and IR ($\lambda_{eff} \cong 8100$ Å) were done at the Newtonian focus of the 193-cm (f/5) telescope of the Haute Provence Observatory. The determination of their positions, angular diameters, global brightness, and the discussion of their nature, "open" or "globular" are the subject of this work. (auth)

38077 HYDROGEN BURNING SUPERMASSIVE STARS. Appenzeller, I. (Univ., Goettingen, Ger.); Fricke, K. Astron. Astrophys.; 12: No. 3, 488-90(Jun 1971).

Hydrostatic equilibrium models for hydrogen burning supermassive stars of $5 \times 10^5 \leqq M/M_\odot \leqq 5 \times 10^7$ were derived by numerical integration of the stellar-structure equations. The results were compared with Newtonian polytropes of index n = 3. Although the computed models were found to be fully convective only for $M \gtrsim 3 \times 10^6 M_\odot$, and although general relativistic mechanics was used in the calculations, the results are found to be in good agreement with earlier results derived from Newtonian polytropic models. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 38184.

38078 (TID–3320(Suppl.1)) PULSARS BIBLIOGRAPHY. Matheny, William D. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1971. 64p. Dep. NTIS.

This bibliography on pulsars, neutron stars, black holes, supernova remnants, and cosmic x-ray sources, covering the literature of 1970, consists of 380 abstracts taken from Nuclear Science Abstracts. Author and subject indexes are included. (W.D.M.)

38079 CRAB NEBULA. ANCIENT HISTORY AND RECENT DISCOVERIES. Rossi, B. B. (Massachusetts Inst. of Tech., Cambridge). pp 237-56 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

A model is developed that pictures the crab nebula as a thin plasma cloud containing a weak magnetic field, with a fast-rotating strongly magnetized, neutron star at its center. The magnetization of the star does not have axial symmetry with respect to the spin axis, so the rotation gives rise to time-varying electromagnetic fields, which, in some way, are capable of accelerating electrons. (W.D.M.)

38080 COMMENTS ON THE REES MECHANISM. Jennison, R. C. (Univ. of Kent, Canterbury, Eng.). Nature (London) Phys. Sci.; 231: No. 21, 88(24 May 1971).

Comments are made on the suggestion by Rees (Nature 229: 312 (1971)) that bifurcated cosmic radio sources result from the energising agency of low-frequency electromagnetic waves emanating from a central rotating object. Some further experimental work is suggested. The possibility is mentioned that the Cassiopeia A spur could be a result of the Rees mechanism; this would require that the supernova remnant originally had a pulsar-like object at its centre. Searches for such a pulsar have so far been unsuccessful, but further investigations are desirable. (UK)

38081 LOWER LIMITS OF THE MASSES OF QUASI-STELLAR OBJECTS. Whitmire, D. P.; Davids, C. N. (Univ. of Texas, Austin). Nature (London) Phys. Sci.; 231: No. 22, 102-3(31 May 1971).

The various independent methods available for estimating lower limits to the masses of QSOs are briefly reviewed, and a method is considered that might be applicable to QSOs showing an absorption redshift, Z_{abs}, greater than the emission redshift, Z_{em}. In these cases there is little doubt that Z_{abs} is intrinsic to the QSO, and the most likely explanation is that expanding shells or filaments of gas have been ejected and are falling back on the QSO. With this interpretation of absorption it is shown how lower limits can be placed on the mass of a QSO having $Z_{abs} > Z_{em}$. (UK)

38082 OBSERVATIONAL STUDY OF THE OPTICAL VARIABILITY OF QUASI-STELLAR OBJECTS. Angione, Ronald

James. Austin, Tex.; Univ. of Texas (1970). 305p. University Microfilms Order No. 71-11,509.

Thesis.

The nature of quasi-stellar objects (QSO) was examined by studying their optical brightness changes. The changes were studied with time-scales of 70 years (utilizing the Harvard Historical Plate Collection) down to time-scales of 3 minutes (from recent photoelectric observations made at McDonald and Cerro Tololo Observatories). The measurement of the Harvard photographic plates necessitated the setting-up of photoelectric sequences for each QSO. The photographic light curves yielded several findings. First, each of the twenty-two QSO's in the program was found to be variable, and these variations have been occurring for at least 70 years. No general trend in brightness was found for the QSO's. There is a range of behavior from rapid flare-like variations taking place in a few hours to slow quasi-periodic changes, with a time-scale of 10 to 20 years. The general appearance of the QSO light curves is similar to those of the Seyfert galaxies. Observations to detect short-time-scale variations yielded a change of 0.3 magnitudes/hour for 3C 454.3, which sets a maximum diameter on a single source of about 4×10^9 km. Three other QSO's (0405-12, 0159-11, and PHL 658) monitored for short-time-scale changes remained constant within about 0.03 magnitudes during eight nights in August, September, and October, 1968. 3C 273 was observed for two to three hours on each of five nights with a time-scale of 1.5 minutes. The standard deviation on each night was less than 0.01 magnitudes indicating no detectable variations. Two recent flare-ups of 3C 454.3 correlate with increases in the one-centimeter radio flux. The lack of a time lag suggests that inverse Compton scattering may be important. Assuming a cosmological origin for the redshift of the QSO's, then some evidence for a correlation is found between intrinsic brightness and amplitude of variability, with the intrinsically brightest QSO's showing the smallest amplitude. This gives support to the Wheeler hypothesis that the intrinsically brightest QSO's would be composed of the largest number of sources and show the smallest amplitude of variation. The three intrinsically brightest QSO's studied (3C 273, 0405-12, and 0237-23) are also suggested to be quasi-periodic on the basis of power spectrum analysis of their light curves; the evidence is more suggestive than conclusive. (Diss. Abstr. Int., B)

38083 RADIO OBSERVATIONS OF SELECTED H II REGIONS. Wendker, H. J. (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 13: No. 1, 65-70(Jun 1971).

High-resolution radio observations are reported for several selected H II regions. Their radio and optical appearances are compared. (auth)

38084 CIRCULAR POLARIZATION OF THE RADIO SOURCE PKS 1127-14 AT 3240 MHz. Seaquist, E. R. (Univ. of Toronto). Nature (London) Phys. Sci.; 231: No. 22, 93-7(31 May 1971).

Observations of circular polarization at 3,240 MHz are presented for the QSO PKS 1127-14. The results are discussed in the light of other observational data, and it is concluded that this object contains a component with a magnetic field of at least 6.4×10^{-2} G, provided the mechanism involved is ordinary synchrotron radiation. (auth) (UK)

38085 FREQUENCY STRUCTURE IN INDIVIDUAL STRONG PULSES OF NP 0532. Heiles, Carl (Arecibo Observatory, Puerto Rico); Rankin, John M. Nature (London) Phys. Sci.; 231: No. 22, 97-100(31 May 1971).

Isolated, extremely intense single pulses from the pulsar in the Crab Nebula, NP 0532, were responsible for its early detection and continue to be interesting in themselves. The properties of individual strong pulses observed at widely different radio frequencies are described, and the feasibility of attempting to detect strong single pulses below 70 MHz is discussed. (auth) (UK)

38086 IONIZATION STRUCTURE OF A NEBULA PHOTOIONIZED BY A FLAT SPECTRUM. Bahcall, John N. (California Inst. of Tech., Pasadena. Tel-Aviv Univ., Israel); Bahcall, Neta A.; Kozlovsky, Ben-Zion. Contract AT(11-1)-68. Astron. Astrophys.; 13: No. 1, 1-6(Jun 1971).

Analytic approximations were developed for the ionization structure of a medium that is photoionized by a flat spectrum. The presence of a diffuse ionization zone depends on the precise form of the ultraviolet ionization spectrum. For a photon number spectrum that falls off as ν^{-1} there is a diffuse ionization structure, and for a spectrum that falls off like ν^{-4} there is a more classical Strömgren-like behavior with a half-width an order of magnitude smaller than in the ν^{-1} case. The basic equations are also presented for a more general class of spectral indices as well as a power-law behavior of the total density on distance from the ionization source. (auth)

38087 IDENTIFICATION OF SOUTHERN QUASI-STELLAR OBJECTS. Shimmins, A. J. (CSIRO, Sydney); Bolton, J. G.; Peterson, B. A.; Wall, J. V. Astrophys. Lett.; 8: No. 3, 139-43 (May 1971).

Fifteen quasi-stellar objects south of declination −33° were found from combined radio and optical observations. Sixteen objects between declinations +4° and −26°, previously suggested as QSOs, were confirmed by two-color photography. (auth)

38088 POSSIBLE MECHANISM FOR PULSED GAMMA RADIATION FROM A ROTATING NEUTRON STAR. Dean, A. J.; Turner, M. J. L. (CNR, Milan). Astrophys. Lett.; 8: No. 3, 145-9(May 1971).

The Gunn and Ostriker acceleration mechanism is shown to produce sharp double pulses of electrons. Their production of pulsed gamma radiation by synchrotron emission, whose flux agrees with present measurements on the Crab Pulsar, requires the existence of a magnetic field of intensity $\gtrsim 10^4$ G confined to a region $\lesssim 10^4$ cm in depth. It is shown that the mechanism works for a range of possible distances of the field from the star extending from 10^9 to 10^{16} cm, and that the spectral index of the calculated flux, −0.75, is in agreement with experiment. (auth)

38089 GENERATION OF MAGNETIC FIELDS IN ROTATING STARS AND QUASARS. Bisnovati-Kogan, G. S. (Inst. of Applied Mathematics, Moscow); Vainshtein, S. I. Astrophys. Lett.; 8: No. 3, 151-2(May 1971).

The possibility is shown that magnetic fields may be generated in rapidly rotating stars of early spectral classes by the mechanism of the turbulent dynamo. The example of a star of 30 $M_\odot$ is considered. The possibility of generation of the field in different models of quasars is discussed. (auth)

38090 NEUTRAL HYDROGEN IN THE REGION OF THE DUST CLOUD L 134. Sancisi, R. (Kapteyn Lab., Groningen, Netherlands). Astron. Astrophys.; 12: No. 3, 323-31(Jun 1971).

In the direction of the dust cloud L 134 profiles of the 21-cm emission line obtained with the 25-meter radio telescope at Dwingeloo show a decrease of 7.5°K (about 12%) in peak-brightness temperature as compared with nearby positions on the sky. The H I emission minimum has a velocity half-width of about 5 km/s ($\sigma \cong 2$ km/s) and is centered at radial velocity +0.5 km/s, which differs significantly from the velocity of the OH emission, +3 km/s, and possibly from that of H_2CO absorption, +1.7 km/s. The observed deficiency may be attributed to: (i) a deficiency of atomic hydrogen in the dust cloud, possibly due to formation of molecular hydrogen; or (ii) cool hydrogen associated with the dust, and either lying in front of a hotter background or embedded in a gas layer. The latter explanation is most likely. However, the presence of a large amount of H_2 is not ruled out. L 134 seems an ideal candidate for a closer study of the interstellar medium inside dense concentrations of dust. (auth)

38091 POPULATION INVERSION IN THE OUTER LAYERS OF A RADIATING GAS. Jefferies, John T. (Univ. of Hawaii, Honolulu). Astron. Astrophys.; 12: No. 3, 351-62(Jun 1971).

On the basis of solutions to the coupled radiative transfer equations for multiplet lines, simple physical arguments are presented on the expected distribution of population among closely spaced energy levels in the ground, or a low-lying state, of an atom or molecule. It is shown that, because uncoupling of multiplet lines will occur in the outer layers of a radiating gas, population "anomalies" will occur in the fine-structure states associated with the upper and/or lower levels of the multiplet transitions. Order-of-magnitude estimates suggest that the mechanism is able to account for some aspects of the 18-cm OH emission, though better solutions of the coupled transfer equations are needed before proper observational comparison is possible. It is suggested that atoms with p and p^2 configurations may be expected to have inverted populations among the ground-state levels in the outer layers of an optically thick gas. A list is given of infrared and submillimetric atomic lines that may show amplification in astronomical sources. Two lines of C I are accessible to ground-based (high-altitude) instrumentation, and these may merit a diligent search. (auth)

Solar Phenomena

38092 (NP-18857) CHEMICAL COMPOSITION OF THE SOLAR ATMOSPHERE. Report No. 31. Hauge, Oe.; Engvold, O. (Oslo Univ. (Norway). Institutt for Teoretisk Astrofysikk). 1970. 29p. Dep. NTIS (U. S. Sales Only).

The present working values for the solar abundance of chemical elements are listed. The solar abundance of 65 chemical elements is known. The abundance of some elements determined from the

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photospheric spectrum is based on one line only (Ga, Ge, Sn, Er, Yb, Lu, Au, and Th) and the results may be erroneous. For seven elements (B, Rh, Cs, Hg, Tl, Bi, and U) only upper limits are given for the abundances. Lines of Ho and Tb are suspected in the solar photospheric spectrum, but the abundances of these elements are not determined. For 21 chemical elements with atomic number less than 38, the solar abundances are derived by two or more different methods. A separate list is made for solar isotope ratios of eight elements that have been investigated so far. (auth)

38093 MAGNETIC STRUCTURE OF SUNSPOT GROUPS WHICH PRODUCE SOLAR PROTON FLARES. Sakurai, Kunitomo (Goddard Space Flight Center, Greenbelt, Md.). J. Geomagnet. Geoelec.; 21: No. 1, 463-70(1969).

Solar proton flares take place due to the release of magnetic energy accumulated within the sunspot magnetic-flux tube of force lying in the chromosphere and the lower corona due to the twisting of it, which is seen from the rotational motion of sunspot groups on the photospheric surface. This rotational motion is counterclockwise (clockwise) in the northern (southern) hemisphere when viewed from the Earth. The accumulation of magnetic energy within the flux tube due to this motion continues to proceed until some instability is induced along the flux tube. It is further shown that the magnetic configuration of sunspot groups is important for the triggering of a solar proton flare. (auth)

38094 SOLAR CYCLE RESPONSE IN THE HORIZONTAL FORCE OF THE EARTH'S MAGNETIC FIELD. Bhargava, B. N.; Yacob, A. (Colaba and Alibag Observatories, Bombay). J. Geomagnet. Geoelec.; 21: No. 1, 385-97(1969).

The solar-cycle line was resolved in the horizontal force by power-spectrum analysis using 120 years' data of Colaba–Alibag. Having established the presence of a large signal, the variation and phase in relation to solar cycle were computed from the data of eight observatories by the application of an appropriately designed band-pass numerical filter. The response in the horizontal force was found to be larger and more uniform than estimated earlier. At most of the stations, the response was still greater during peaks of odd solar cycles, suggesting a 22-year variation in the field. An unexpected 17- to 18-year cyclic variation was also noticed in the autocorrelation function of the data series of Colaba-Alibag. The data of this station, after removal of the secular variation, also suggest the presence of an 80-year cycle in the horizontal force. (auth)

38095 AN EXPERIMENTAL DETERMINATION OF VAN DER WAALS BROADENING TEMPERATURES OF ASTROPHYSICAL INTEREST. Evans, John Martin Jr. Boulder, Colo.; Univ. of Colorado (1970). 217p. University Microfilms Order No. 71-5889.

Thesis.

Widths of shock-excited emission lines at temperatures characteristic of the photosphere and low chromosphere of the Sun were analyzed. Metallic-impurity compounds were added to the conventional pressure-driven shock tube in a powdered form as an aerosol, and the emission line profiles were analyzed with a rapid scanning Fabry–Perot interferometer. Line widths due to broadening by argon were measured for SiI λ4102 and λ5948 and for CsI λ4593. The latter line was also measured as broadened by neon and the shift of SiI λ4102 was measured for broadening by argon. Significant disagreements with present theory are found, the experimental values being larger than theory by factors of 1.5 to 2. Analysis of the theory indicates that the major error is in the assumption of a simple $1/r^6$ potential. (Diss. Abstr. Int., B)

38096 f-SUM RULE AND Fe I f-VALUES. Allen, C. W. (Univ. of London Observatory, Mill Hill Park, Eng.). Mon. Notic. Roy. Astron. Soc.; 152: No. 3, 295-305(1971).

Earlier calculations of f-values from the f-sum rule had not made allowance for transitions violating LS coupling. An evaluation of this effect has made it possible to establish an absolute scale for Fe I that is independent of experimental work and to correct the extensive gf measurements of Corliss and Warner on to that scale. The corrected gf values are in satisfactory agreement with recent laboratory measurements and do not show any strong deviations depending on either λ or E.P. (auth) (UK)

38097 FREQUENCY OF SUNSPOT GROUPS AS A FUNCTION OF THEIR AVERAGE SURFACE AREAS. Trellis, Michel (Univ. Paris, Nice). Compt. Rend., Ser. B; 272: No. 17, 1026-8(26 Apr 1971). (In French).

The distribution of sunspot areas exhibits significant differences along the longitudinal zones in which they are concentrated. (auth) (France)

38098 SEGREGATION OF MATERIAL WITH REFERENCE TO THE FORMATION OF THE TERRESTRIAL PLANETS. Williams, I. P.; Crampin, D. J. (Queen Mary Coll., London). Mon. Notic. Roy. Astron. Soc.; 152: No. 3, 261-75(1971).

The problem of the settling of grains in a gravitational field in the presence of a resisting gas when the grains are assumed to be growing by accretion was investigated by numerical methods. The results show that the time of fall is fairly insensitive to the initial conditions assumed. The rate of evaporation of the resisting gas, caused by the release of energy from the falling grains, was also investigated and found to be considerable. (auth) (UK)

38099 THREE-DIMENSIONAL MODEL OF A LARGE CORONAL STREAMER WITH ACTIVE REGION ENHANCEMENT. Koutchmy, S. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 13: No. 1, 79-98(Jun 1971). (In French).

The main results are the identification of a large streamer and enhancement with underlying chromospheric filaments and plages, respectively, of the streamer for which the lower part (bulb) has a completely different structure compared with those of the models reviewed previously; demonstration of the existence of a tangential discontinuity and large magnetic fields in the midcorona; and finally the confirmation of the dominant role of the large streamer as a contributor to corpuscular emission (solar wind). (W.D.M.)

38100 CORONAL TURBULENCE AND TYPE II BURSTS. Aubier, M.; de la Noee, J. (Observatoire, Meudon, France). Astron. Astrophys.; 12: No. 3, 491-3(Jun 1971).

Spectral records of Type-II bursts sometimes show sporadic enhancements of emission: this fine structure is related to the characteristics of coronal inhomogeneities. (auth)

38101 ISOTOPIC LINES OF THE MgH MOLECULE. Boyer, R. (Observatoire, Meudon, France). Astron. Astrophys.; 12: No. 3, 464-7(Jun 1971).

For some extended spectral analyses and solar spectroscopy applications, it is necessary to know the wavelengths of the ^{25}MgH and ^{26}MgH lines of the (0,1), (1,2), and (2,2) bands. The calculations were based on Guntsch (1939) laboratory data, and were done according to the method given by Branch (1970). (W.D.M.)

38102 OBSERVATIONS OF THE QUIET SUN AT DECAMETER WAVELENGTHS: EFFECTS OF SCATTERING ON THE BRIGHTNESS DISTRIBUTION. Aubier, M.; Leblanc, Y.; Boischot, A. (Observatoire, Meudon, France). Astron. Astrophys.; 12: No. 3, 435-41(Jun 1971).

The emission from the quiet Sun was observed at 60, 36.9, and 29.3 MHz with the large Arecibo radiotelescope. The flux densities and dimensions of the source were determined, which gave the brightness temperature in the direction of the center of the Sun. The values obtained decreased rapidly with frequency (T_b = 0.60 10^{6}°K, 0.50 10^{6}°K and 0.38 10^{6}°K at 60, 36.9 and 29.3 MHz, respectively). It is shown that these values cannot be explained either by the generally adopted models of N_e and T_e in an homogeneous corona, or by changing the gradient of $N_e(\rho)$ or $T_e(\rho)$. To explain the observed values, the effect of scattering by an irregular corona was introduced. This does indeed lead to a decrease in the flux density and an increase in the size of the source, as compared with the values obtained without scattering. Consequently the apparent brightness temperature decreases. It is shown that the scattering effects increase when the frequency decreases and can explain the observed characteristics of the emission from the quiet Sun at low frequencies, although these effects are negligible at shorter meter wavelengths. (auth)

38103 RELATIONSHIP BETWEEN DRIFT PAIR BURSTS AND DECAMETRE TYPE III SOLAR RADIO EMISSION. de la Noee, J.; Moeller Pedersen, B. (Observatoire, Meudon, France). Astron. Astrophys.; 12: No. 3, 371-8(Jun 1971).

Observations of forward and reverse drift pair bursts obtained with a highly sensitive spectrograph reveal that these bursts are closely associated with Type-III emission. The presence of a simultaneous single drifting burst, which could be the emission at the fundamental frequency, is sometimes observed. An explanation is proposed for the drift pairs, which postulates the existence of sources of electron acceleration in the upper corona. (auth)

38104 BROADENING OF THE BALMER LINES DURING A FLARE. Semel, M.; Soru-Escaut, I. (Observatoire, Meudon, France). Astron. Astrophys.; 12: No. 3, 340-50(Jun 1971). (In French).

The hypotheses involved in the interpretation of flare spectra were chosen as follows: (1) the total number of absorbants per cm^2, N_2, in the emission layer should be practically the same for all the members of the Balmer series; and (2) the maximum intensity in each line approximates the source function. With the help of these hypotheses, the analysis of the observational data

showed that, independently of the broadening mechanism, the first members of the series are saturated. Consequently, it was necessary to study the line wings and to introduce a hypothesis concerning the broadening mechanism: either Stark or Doppler. As a criterion of choice between these two effects, the ratios of the optical depths τ, corresponding to different members of the series, were examined. This method led to the conclusion that the Stark effect predominates. A coherent solution for the whole series is proposed. Finally, the problem concerning the determination of the electron density n_e and of N_2 is discussed. The possible effects of inhomogeneities of the electron density are suggested. (auth)

38105 TIME SPLITTING OF DECAMETER SOLAR RADIO BURSTS. Sastry, Ch. V. (Astrophysical Observatory, Kodaikanal, India). Astrophys. Lett.; 8: No. 3, 115-19(May 1971).

Solar radio bursts were observed with a multichannel receiver with frequency separations of 100 to 200 kHz, at a center frequency of 25 MHz. The time resolution was 15 msec. Some properties of double bursts are described. (auth)

Galaxies

38106 (NP-18866) ABSENCE OF DISCRETE ABSORPTION CLOUDS BELOW THE GALACTIC PLANE IN THE GALAXY CLUSTER AREA 0024 + 1654. Report No. 29. Stabell, Rolf (Oslo Univ. (Norway). Institutt for Teoretisk Astrofysikk). 1970. 12p. Dep. NTIS (U. S. Sales Only).

Spectra of 60 stars on objective prism plates taken with a Schmidt camera were measured. The plates cover the galaxy cluster area 0024 + 1654. The stars are all earlier than G0. Their colors and absolute magnitudes were calculated. The color excess as a function of distance modulus was determined and the galactic absorption in this area was found. The result agreed well with the value calculated from the cosecant law. No additional absorption due to discrete clouds below the galactic plane was found. (auth)

38107 RADIUS-MAGNITUDE DIAGRAM OF ELLIPTICAL AND S0 GALAXIES APPLIED TO THE EXTRA-GALACTIC DISTANCE SCALE. Brookes, Robert A.; Rood, Herbert J. (Wesleyan Univ., Middletown, Conn.). Astrophys. Lett.; 8: No. 2, 61-5(Apr 1971).

Plots of radius vs magnitude for elliptical and S0 galaxies in the core of the Coma cluster show bright and faint sequences separated a transition region, features discovered previously by Sersic (1968) in a diagram for a sample of nearby and Virgo cluster ellipticals. The application of the diagram to obtain distances to clusters is explored. (auth)

38108 VARIATIONS IN THE 5-GHz FLUX DENSITY OF THE NUCLEUS OF M87. Graham, I. (Cavendish Lab., Cambridge, Eng.). Nature (London); 231: No. 5300, 253-4(28 May 1971).

Variations in the radio flux density of a compact component in the nucleus of M87 over time scales of less than a year are reported. Observations were made at 5 GHz with the Cambridge 1-mile telescope. Previous observations have shaped M87 into three compact components, the central of which is coincident with the optical nucleus. Since the other two components have very large physical dimensions their contribution to the emission cannot fluctuate on a time scale of a few years and it is possible to investigate small variations of flux density of the nuclear component by comparing it with the more extensive components. Results are shown graphically and in tabular form. The time scale of the variations was apparently similar to that observed for the x rays, but there is very little x-ray information available. Any correlation between the x rays and radio variation would greatly strengthen the case for the x rays originating from the inverse Compton effect within the nucleus of M87. (UK)

38109 COMMENTS ON ANOMALOUS RED SHIFTS. Arp, H. (California Inst. of Tech., Pasadena). Nature (London) Phys. Sci.; 231: No. 22, 103-4(31 May 1971).

A reply is made to Lewis (Nature Phys. Sci., 230: 13(1971)) who states that "it is not surprising to find no confirmation of Arp's reported anomalous redshifts in groups of galaxies" (Nature, 225: 1033(1970)). (UK)

38110 ROTATION CURVES IN TURBULENT PROTO-GALAXIES. Saslaw, William C. (Univ. of California, Berkeley. Univ. of Virginia, Charlottesville. Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 152: No. 3, 341-59(1971).

Rotation curves contain information about the early dynamical history of galaxies. Quasi-stationary rotation curves for highly turbulent, gaseous, nonmagnetic protogalaxies, which are acted upon by external torques, were calculated. These torques arise from nearby condensations. The detailed structure of the curves can vary widely; it depends mainly upon the relative strengths of torque and turbulence and upon the initial density distribution. Nearly all the rotation curves, however, share a similar general form. The central regions of the protogalaxy have constant angular velocity, intermediate regions have varying angular velocity, and outer regions tend to a different constant angular velocity. The main observed properties of rotation curves for evolved Sb and Sc galaxies can be reproduced if the initial density and viscosity distributions are not strongly centrally concentrated, if initial turbulent velocities are less than several hundred km s^{-1}, if the central solid-body regions of protogalaxies do not contract substantially as they evolve with detailed angular momentum conservation, and if the outer regions evolve nonhomologously. (auth) (UK)

38111 SUPERGIANT GALAXIES WITH MULTIPLE NUCLEI. Jenner, David Charles. Madison, Wis.; Univ. of Wisconsin (1970). 51p. University Microfilms Order No. 71-24,573. Thesis.

New low-dispersion, image-tube spectra extend the knowledge of supergiant (cD) galaxy spectral characteristics to a sample of cD galaxies not previously identified with strong radio sources. Only two of twenty radio quiet cD galaxies show strong λ3727 in emission. One of the two emission-line galaxies, in Abell 1795, is most likely the radio source 4C 26.42. The spectra also provide redshifts and relative radial velocities for cD and dumbbell (db) galaxies with double nuclei. A sample of ten cD and db galaxies with double nuclei, analyzed with the statistical method of Holmberg and Page, yields a mean mass of $6(\pm 4) \times 10^{12}$ solar masses. The large mean mass is credible if the double nuclei form bound systems. (Diss. Abstr. Int., B)

38112 LINEAR POLARIZATION OF PART OF THE NORTHERN SKY AT 73-cm WAVELENGTH. Baker, J. R.; Smith, F. G. (Univ. of Manchester, Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc.; 152: No. 3, 361-76(1971).

A survey of polarized background radio emission, covering $23h \rightarrow \alpha \rightarrow 11h$, $53° \rightarrow \delta \rightarrow 90°$, was made at 73-cm wavelength, with a beam width of 46′ arc and a sensitivity of 0.2°K in polarization brightness temperature. The results are presented in tabular form, as a contour map, and as a plot of polarization vectors. The position angles were corrected for ionospheric Faraday rotation. (auth)

38113 STRUCTURE OF INTERSTELLAR MATTER. II. A CORRELATION BETWEEN INTERSTELLAR GAS ABSORPTION AND DUST EXTINCTION? Rohlfs, Kristen (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 13: No. 1, 46-51(Jun 1971).

From the measured color excesses of O and B stars, estimates for the visual extinction of 17 radio sources were derived. Comparing these with 21-cm absorption measurements by Radhakrishnan et al.(1971) and Clark (1965) a linear regression was obtained. The slope of this relation was used to determine the ratio of the gas density to the dust density in the obscuring clouds. A value of $\rho H/\rho_d = 50$ was found. From the fact that the relation was approximately linear, some constraints on the law of dust formation in the interstellar medium were derived. (auth)

38114 APERTURE SYNTHESIS STUDY OF NEUTRAL HYDROGEN IN THE GALAXY M101. I. OBSERVATIONS. Rogstad, D. H. (California Inst. of Tech., Pasadena. Kapteyn Lab., Groningen, Netherlands); Shostak, G. S. Astron. Astrophys.; 13: No. 1, 99-107(Jun 1971).

Synthesis observations of neutral hydrogen emission in the spiral galaxy M101 obtained with the Owens Valley twin-element interferometer are presented. The spatial resolution is 4′ of arc; and the velocity resolution is 21 km s^{-1}. The observations are given in the form of contour maps of the integral and the mean velocity of the H I profile at each position in the galaxy, and a line profile for the galaxy as a whole. A contour map of the 21-cm continuum radiation is also presented. (auth)

38115 APERTURE SYNTHESIS STUDY OF NEUTRAL HYDROGEN IN THE GALAXY M101. II. DISCUSSION. Rogstad, D. H. (California Inst. of Tech., Pasadena. Kapteyn Lab., Groningen, Netherlands). Astron. Astrophys.; 13: No. 1, 108-15(Jun 1971).

The observations described in paper I are discussed with the following conclusions: there is a close correspondence between features in the surface density of both light and H I in M101; the H I velocity field contains streaming motions in agreement with the predictions of the first-order density wave theory of spiral structure; and there is evidence for expansion motions of at least 40 km s^{-1} in the central region of the galaxy. (auth)

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38116 INFRARED LINE RADIATION FROM THE NEIGHBORHOOD OF THE GALACTIC CENTER. Pottasch, S. R. (Kapteyn Astronomical Inst., Groningen, Netherlands). Astron. Astrophys.; 13: No. 1, 152-6(Jun 1971).

Calculations were made on the amount of line radiation in the infrared (between 20 μ and 200 μ) to be expected from the "thermal" regions in the neighborhood of the galactic center. A comparison was made with the observed radiation in this wavelength region. Although the predicted line radiation is an order of magnitude lower than the observed radiation, the predicted flux depends on the assumed abundance, which may be higher than the solar values used. In any case, at least 10 lines are expected to be present in observable strength, and observation of these lines can provide an accurate determination of the abundances of five elements at the galactic center. (auth)

38117 DIFFUSE INTERSTELLAR BANDS AND GARNET GRAINS. Dorschner, J. (Univ., Jena, Ger.). Nature (London) Phys. Sci.; 231: No. 23, 124-6(7 Jun 1971).

It was recently suggested that the observed diffuse interstellar bands may be caused by transitions in 3d ions situated at the tetrahedral and octahedral sites in the lattices of interstellar silicate grains. It was also suggested that the grains might consist of iron-bearing garnets of the almandine and andradite type, and that the 4430Å band may be caused by the field-independent transition $^6A_1$, (S) $\rightarrow$ $^4A_1$, ^4E (G) in the Fe^{3+} ions of andradite. There are, however, several matters that were not sufficiently taken into account in these suggestions. Firstly, the coincidence of the wavelength of a diffuse interstellar band with that of a known transition in some material does not suffice to decide on the composition of the interstellar dust. There are also important criteria such as oscillator strength of the proposed transition, cosmic abundance of the elements, and the likelihood of formation of such grains as may be suggested as "host" for the absorber, to be considered; these are discussed. Some special objections to interstellar garnets are also discussed. (UK)

38118 EVIDENCE FOR A NEW CLASS OF VERY EXTENDED H II REGIONS IN THE DISKS OF Sc GALAXIES. Monnet, G. (Observatoire, Marseille). Astron. Astrophys.; 12: No. 3, 379-87(Jun 1971).

Perot–Fabry and grating spectrography in Hα and [N II] 6584 Å lines has led to the discovery of extended disks of ionized hydrogen in a number of Sc galaxies. The Hα/[N II] ratio was obtained for M33 and M101 and is ~1.5. Physical parameters derived from absolute line intensities and kinematical data are discussed. (auth)

38119 LOOP STRUCTURES: REVIEW AND INTERPRETATION OF THE OBSERVATIONS. Haslam, C. G. T.; Kahn, F. D.; Meaburn, J. (Nuffield Radio Astronomy Lab., Jodrell Bank, Eng. Univ. of Manchester, Eng.). Astron. Astrophys.; 12: No. 3, 388-97(Jun 1971).

The observational evidence concerning the known loop structures in the Galaxy was collected. The data came from radio-continuum surveys, from optical observations in Hα, from an analysis of interstellar polarization, and from 21-cm surveys at low and, to some extent, at high velocities. Interpretation of the results is that the typical loop structure is a spherically symmetrical expanding shell within the disk of the Galaxy. The typical shell contains a mass of 10^4 $M_\odot$, and an amount of kinetic energy of the order of 10^{51} erg. If the local density of loop structures is representative of their density in the galactic disk as a whole, then their total contribution would, on this interpretation, be extremely important in the energy balance of the interstellar medium. (auth)

38120 ORIENTATION OF DUST GRAINS IN THE INTERSTELLAR SPACE. Cugnon, P. (Observatoire Royal de Belgique, Brussels). Astron. Astrophys.; 12: No. 3, 398-420(Jun 1971).

A Fokker–Planck equation, taking into account collisions with gas atoms and magnetic interactions (Davis and Greenstein theory) was used in order to obtain the angular statistical distribution of the grain axes. The three following situations were especially considered: (1) spheroids of any elongation, with magnetic anisotropy, the magnetic torque being small compared with the kinetic torque (due to collisions); (2) nearly spherical grains, with small anisotropy, any ratio of the magnetic effects to the kinetic effects; and (3) oblate spheroids with high magnetic anisotropy. This last case may correspond to graphite flakes, if they are exhibiting diamagnetic relaxation. A short discussion of the results contained in this paper allows exclusion of this possibility. Results found in the first case were applied to ice prolate spheroids. It is shown that axes ratios between 0.3 and 0.4 give the maximum value of $\Delta m_P/\Delta m_T$. The corresponding value of the magnetic field for "standard conditions" and strictly paramagnetic relaxation is about $2\ 10^{-5}$ G. (auth)

38121 INTERACTION OF METAGALACTIC IONIZING RADIATION WITH GALACTIC HYDROGEN. I. THE FORMATION OF A SLAB-SHAPED HALO. Silk, Joseph (Univ. of California, Berkeley). Astron. Astrophys.; 12: No. 3, 421-7 (Jun 1971).

The metagalactic ionizing radiation interacts with galactic neutral hydrogen to produce shielding slabs of ionized hydrogen at the periphery of the galactic disc. This situation differs from that of the usual Stroemgren approximation in that the power-law nature of the incident ionizing photon flux precludes a sharp transition between H I and H II regions. Simple analytic expressions are given for the variation in degree of ionization with depth into a uniform slab, and the physical conditions in these halo slabs are studied. The presence of such slabs should have several observational consequences, which include in particular the formation of strong interstellar Ca II K lines in the spectra of high-latitude stars. The strength of the corresponding Na I D lines is estimated to be appreciably weaker. The D line strengths are also found to depend critically on the temperature of the halo slab gas, since collisional ionization of Na I becomes important above about 12,000°K. (auth)

38122 SPIRAL STRUCTURE OF OUR GALAXY FROM H II REGIONS. Georgelin, Y. P.; Georgelin, Y. M. (Observatoire, Marseille. Observatoire, Haute Provence, France). Astron. Astrophys.; 12: No. 3, 482-7(Jun 1971).

Advantages and disadvantages were compared of different methods used for studying the Population I: H I regions (21 cm profiles), Ca interstellar (optical radial velocities), H II regions (optical and radio radial velocities), exciting stars (spectrophotometric distances), and OB stars (spectrophotometric distances). Radial velocities of H II regions were combined with spectrophotometric distances of their exciting stars to study the spiral structure and the kinematics of the Galaxy. The results are given. (auth)

38123 POST-ERUPTIVE GALAXY M82. van den Bergh, Sidney (David Dunlap Observatory, Richmond Hill, Ont.). Astron. Astrophys.; 12: No. 3, 474-6(Jun 1971).

Infrared plates obtained with the 200-inch telescope show that the central region of M82 contains about a dozen bright knots. Spectroscopic observations suggest that these knots are super star clusters. These superclusters are up to 100 times brighter than the most luminous star cluster known in the Galaxy. It is suggested that the formation of these superclusters was triggered by the explosion that took place in M82 about 1.5×10^6 years ago. (auth)

Cosmology

Refer also to abstract 39025.

38124 RELATIVISTIC ASTROPHYSICS. VOLUME 1. STARS AND RELATIVITY. Thorne, Kip S.; Arnett, W. David (eds.). Chicago; University of Chicago Press (1971). 537p. $24.00.

Translated from Relyativistskaya Astrofizika by Eli Arlock.

Introductions are presented to such fundamental subjects as the general theory of relativity, thermodynamics and nonequilibrium processes for matter at ultrahigh temperatures and densities, stellar structure and evolution, and stellar dynamics. It is shown how these theoretical tools have been used in the last decade to build models for supernovae, explosions in galaxies, quasars, and cosmic x-ray sources, pulsars, and gravitational-wave sources. (W.D.M.)

38125 ISOTROPY OF COSMIC γ-RAY FLUX BETWEEN 1 AND 6 MeV AND IMPLICATIONS FOR FUTURE INVESTIGATIONS. Stecher, F. W.; Vette, J. I.; Tromble, J. I. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London) Phys. Sci.; 231: No. 23, 122-3(7 Jun 1971).

Recent observations of cosmic γ rays >1 MeV appear to indicate that at least in the 1 to 6 MeV energy range their origin is extragalactic, contrary to earlier findings for energies >100 MeV. A hypothetical integral γ-ray spectrum is shown for the galactic disk, assuming disk origin, for the observed 1- to 6-MeV γ-ray flux. The data are not consistent with 1- to 6-MeV γ-ray spectra generated by diffuse galactic production processes; but extragalactic models that produce isotropic γ-ray fluxes can account for the observed γ-ray intensity. The cosmological pion decay model, which suggests that the flux originated in the early history of the Universe, provides a quantitative fit to the spectral data in this energy range. The flux will probably provide a large background on which both galactic and extragalactic point sources in this energy range will be superimposed. This suggests that high-resolution γ-ray telescopes will be needed to detect discrete sources in this energy range, at present not available. The use of a small satellite in

elliptical orbit could provide new information on the spectrum of the diffuse component between 1 and 15 MeV. (UK)

Planetary Phenomena

Refer also to abstracts 38180 and 38233.

38126 CARBON CHEMISTRY OF THE LUNAR SURFACE. Cadogan, P. H.; Eglinton, G.; Maxwell, J. R.; Pillinger, C. T. (Univ. of Bristol, Eng.). Nature (London); 23: No. 5297, 29-31(7 May 1971).

Indigenous CH_4 and the chemical reaction product CD_4 released by deuterated acid etch of Apollo 11 and 12 lunar samples were examined by gas chromatography. Possible origins for the CH_4 include solar wind synthesis and a small primordial contribution. The CD_4 probably arises from carbide or carbide-like materials contributed by meteorite impact and solar wind implantation. (auth) (UK)

38127 ORIGIN OF LUNAR SOIL 12033. Beadecker, Philip A. (Univ. of California, Los Angeles); Cuttita, Frank; Rose, Harry J. Jr.; Schaudy, Rudolf; Wasson, John T. Earth Planet. Sci. Lett.; 10: 361-4(Feb 1971).

The lunar soil 12033 is distinctly different from both the local rocks at the Apollo 12 site and other lunar samples. It must be a recent deposit, else it would not have retained its identity. It contains a meteoritic component about 0.59 times as large as that in the more typical Apollo 12 soils. The amount of meteoritic component may be either a fortuitous residuum from the object that produced the 12033 material as crater ejecta, or 12033 may consist of a mixture of an exotic component with the local soil in approximately 41 : 59 proportions. The available evidence favors the latter interpretation. (auth)

38128 ELECTRON ENERGY AND DENSITY DISTRIBUTION OF THE JOVIAN MAGNETOSPHERE. Luthey, Joe L. Lawrence, Kan.; Univ. of Kansas (1970). 175p. University Microfilms Order No. 71-13,333.

Thesis.

The energy and numerical density of the electrons causing the Jovian synchrotron emission was determined as a function of equatorial distance from Jupiter from an analysis of the observed radiation at two different frequencies. The radiation measured as a function of angular distance from the planet was reduced to radiation emitted from a cubic centimeter in each of 16 concentric strips $\frac{1}{4}$ planet radius wide, assuming cylindrical symmetry about the planet magnetic dipole axis. A Maxwell Boltzmann distribution was assumed in energy, and the electron emission was calculated at radiation wavelengths of 10.4 and 21 cm. The ratio of the two calculated results to the ratio of the observed emission at these wavelengths was compared to obtain the electron temperature and the numerical density. (TSS) (Diss. Abstr. Int., B)

38129 EFFECT OF THE SOLAR WIND VELOCITY ON THE JOVIAN DECAMETRIC EMISSION. Conseil, L. (Observatoire, Meudon, France); Leblanc, Y.; Antonini, G.; Quemada, D. Astrophys. Lett.; 8: No. 3, 133-7(May 1971).

A close relationship is exhibited between the solar-wind velocity and the phase of Io during radio bursts from Jupiter. This is interpreted by the existence of a plasmasphere around Jupiter. (auth)

Atomic and Molecular Physics

Refer also to abstracts 38630 and 38969.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 37978, 38161, 38424, 38543, 38544, 38565, 38575, and 38912.

38130 (EUR-CEA-FC-587) VACUUM AND NEUTRAL BEAM PRODUCTION IN THE MULTI-INJECTION EXPERIMENT IN A QUADRUPOLAR COIL. Dei-Cas, R.; Bariaud, A.; Becherer, R.; Druaux, J.; Hennion, F.; Valckx, F. P. G. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1971. 34p. (In French). Dep. NTIS (U. S. Sales Only).

The production system for fast neutral beams for a multi-injection experiment in a quadrupolar coil is described. Vacuum calculations show that it is possible to obtain the initial conditions necessary for the exponentiation of the plasma density: $\rho_0 \simeq 10^{-8}$ torr for an intensity $I \simeq 0.25$ to 0.75 A. A prototype injector was built to study the possibility of producing ten neutral beams necessary for this experiment. (France)

38131 OBSERVATION OF AUGER ELECTRONS IN THE ENERGY SPECTRUM OF THE SECONDARY ELECTRONS EMITTED BY COPPER BOMBARDED BY RARE GAS IONS. Viel, Louis; Fagot, Bernard; Colombie, Nicole (Univ., Toulouse). Compt. Rend. Ser. B; 272: 623-5(8 Mar 1971). (In French).

In the energy spectrum of the secondary electrons emitted by copper under argon-ion bombardment (10 to 100 keV), electrons from the $M_{23}VV$ Auger transition were observed. The corresponding peak is located at 57 eV; there are also two adjacent subsidiary peaks, which are attributed to surface plasmon excitation. (auth) (France)

38132 STUDY AND DEVELOPMENT OF A POLARIZED ELECTRON SOURCE. Coiffet, Ph. (Paris Univ., Orsay, France). J. Phys. (Paris); 32: No. 2-3, 113-8(Feb-Mar 1971). (In French).

An intense polarized beam of potassium atoms is produced with a six-pole magnet. The ionization of these atoms by uv radiation in a high magnetic field ($B \geq 600$ G) gives polarized electrons which are accelerated at 80 keV. Polarization of the beam measured by Mott scattering on a gold film attains $72 \pm 2\%$, the total intensity being 2 to 3×10^{-12} amperes. New solutions for increasing the intensity are investigated, including ionization by electrons or spin exchange between polarized atoms and slow electrons. (auth) (France)

38133 METHOD AND APPARATUS FOR GENERATING A CONTINUOUS BEAM OF NEUTRAL ATOMS. Meckel, Benjamin B.; Richelmann, Bernd H. (to Physics Tech. Labs. Inc.). U. S. Patent 3,569,706. 9 Mar 1971. Filed 22 Oct 1965.

A method and apparatus for generating a continuous beam of sputtered neutral atoms that are sputtered from metallic members, condensed layers of gases, single crystals and condensed layers of gases on single crystals, and which continuous beam passes through an aperture providing a directed beam that may be restricted to neutral atoms having a monovelocity by a velocity selector means are described. (auth)

38134 SINGLE CRYSTAL SPUTTERING. Basu, D.; Dey, S. D.; Karmohapatro, S. B. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Instrum. Methods; 93: No. 2, 403-4(1971).

Using ions of argon, krypton, and xenon in the energy range 10 to 35 keV from an electromagnetic isotope separator, sputtering yield of a (110) plane of a silver single crystal was measured. Results show the influence of focusing collision chain length on sputtering. (auth)

38135 DEPENDENCE OF THE ANISOTROPY OF THE SECONDARY ION–ELECTRON EMISSION COEFFICIENT UPON ION ENERGY. Brusilovskii, B. A.; Molchanov, V. A. (Moscow State Univ.). Radiat. Eff.; 8: No. 1-2, 71-6(Mar 1971).

The angular dependences of the secondary ion-electron emission coefficient of copper crystals were studied experimentally in wide angular and energy ranges using Ar, Kr, and Xe ions. The obtained regularities are discussed in terms of the Onderdelinden theory of sputtering. (auth)

38136 MASS-SPECTROMETRIC INVESTIGATION OF IONIC EMISSION FROM BOMBARDMENT OF METALS BY ARGON IONS. Vasil'ev, M. A.; Ivashchenko, Yu. N.; Cherepin, V. T. (Inst. of Metal Physics, Kiev). pp 148-53 of Fazovye Prevrashcheniya. /Svechnikov, V. N. (ed.). Kiev; Naukova Dumka (1970). (In Russian).

The secondary ionic emission arising from the bombardment of various metals with a beam of positive Ar ions was studied. Target materials included Al, Ti, Mo, V, Cr, Zr, Ge, Nb, Fe, Ni, Cu, Pd, C, and Zn. A universal attachment is suggested which permits use of the mass spectrometer both for study of secondary positive ions and for the customary isotopic analysis with standard ion sources. (tr-auth)

Atomic and Molecular Properties

Refer also to abstracts 38071, 38096, 38101, 38170, 38540, 38541, 38741, and 39042.

38137 SHIFT IN THE HYPERFINE TRANSITION FREQUENCY OF THE HYDROGEN ATOM PRODUCED BY A COHERENT PERTURBATION IN THE PRESENCE OF RELAXATION. Gurkut, Bulent; Schermann, Jean-Pierre, Audoin, Claude (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 272: No. 12, 739-42(22 Mar 1971). (In French).

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The shift in the resonance frequency of a quantum system at two levels produced by a coherent perturbation acting on a system subjected to relaxation mechanisms, when the coherent perturbation does not saturate the transition, is calculated. The theoretical expression for the $\Delta F = 1$, $\Delta m_F = 0$ hydrogen line was experimentally verified, the case when the perturbing frequency was similar to the nonperturbed resonance frequency being of particular interest. (auth) (France)

38138 ARGON LUMINESCENCE INDUCED BY ALPHA PARTICLES. Henck, R.; Voltz, R. (CNRS, Strasbourg). pp 151-68 of Comptes Rendus du 92e Congres National des Societes Savantes. Tome 2. Paris; Bibliotheque Nationale (1970). (In French).

From ninety-second national congress of the Learned Societies; Strasbourg, France (31 Mar 1967). See CONF-670342-(Vol. 2).

Ultraviolet and visible emission from argon excited by alpha particles is discussed. Using methods resembling the single photoelectron technique, the emission spectra for decay in luminescence curves were determined for this gas for pressures between 400 torr and 10 atmospheres. Comparison of experimental data and theoretical analysis enabled the elementary processes responsible for the emission to be studied. It was shown that the emission is due to excited argon molecules. The formation cross section and lifetime were determined for these molecules. (France)

38139 THEORETICAL L_2- AND L_3-SUBSHELL FLUORESCENCE YIELDS AND L_2–L_3X COSTER–KRONIG TRANSITION PROBABILITIES. Chen, Mau Hsiung (Univ. of Oregon, Eugene); Crasemann, Bernd; Kostroun, Vaclav O. Phys. Rev., A; 4: No. 1, 1-7(1 Jul 1971).

L_2-subshell fluorescence yields ω_2 and L_2-L_3X Coster–Kronig transition probabilities f_{23} were calculated for 21 elements with atomic numbers $26 \leq Z \leq 93$, and L_3 fluorescence yields ω_3 were computed for 14 atoms with $26 \leq Z \leq 85$. Radiationless transition probabilities were calculated in j–j coupling from screened nonrelativistic hydrogenic wave functions. All contributing Auger matrix elements including states through $4f_{\frac{5}{2}}$ were included. The theoretical Auger widths were combined with Scofield's x-ray emission rates to derive fluorescence yields. Results from ω_2 and ω_3 are in very good agreement with experiment. The calculated Coster–Kronig transition probabilities are close to those derived by McGuire from a self-consistent-field potential. However, the theoretical f_{23} curves differ by ~35% from measured values of f_{23}. No explanation for this discrepancy has been found. (auth)

38140 DYNAMIC POLARIZABILITIES AND REFRACTIVE INDEXES OF H^- AND Li^+ IONS. Chung, Kwong T. (North Carolina State Univ., Raleigh). Phys. Rev., A; 4: No. 1, 7-11 (1 Jul 1971).

A variational perturbation method is used to evaluate the first-order wave functions of H^- and Li^+ in the presence of a monochromatic electromagnetic field. These functions are utilized to calculate the dynamic polarizabilities and refractive indexes of H^- and Li^+ ions. Converged results are obtained for both systems. The converged static polarizability of H^- in the present calculation is shown to be 206.0 a.u., which compares favorably with previous theoretical calculations. The wavelength for the Li^+ 1^1S-2^1p transition from the dynamic polarizability calculation, 199.16 Å, is compared with the exact theoretical value of 199.32 Å. (auth)

38141 LAMB SHIFT IN SINGLY IONIZED HELIUM. Narasimham, Musti A. (IBM Components Div., Hopewell Junction, N. Y.); Strombotne, Richard L. Phys. Rev., A; 4: No. 1, 14-32 (1 Jul 1971).

The energy separation $\mathcal{S}$ between the $2^2S_{\frac{1}{2}}$ and $2^2P_{\frac{1}{2}}$ states of singly ionized helium was measured using a microwave method. Helium atoms in the space between the plates of a spherical-mirror Fabry–Perot resonator are bombarded continuously by electrons of 200-eV energy to produce helium ions in the $2^2S_{\frac{1}{2}}$ metastable state. The applied modulated rf power induces transitions in the metastable ions to the short-lived $2^2P_{\frac{1}{2}}$ state. The 40.8-eV photons emitted by the decay of the $2^2P_{\frac{1}{2}}$ ions to the ionic ground state $1^2S_{\frac{1}{2}}$ are quantum converted to visible photons by a scintillator and are then guided to a photomultiplier. The output of the photomultiplier is detected and amplified synchronously with the rf power. The experiment makes use of the Zeeman effect of the fine structure and is performed in an applied homogeneous magnetic field. Three different operating values for the helium pressure are used and the result is extrapolated to a zero-pressure value. A thorough search was made for all possible systematic errors in the experiment. The value for $\mathcal{S}$ thus obtained is 14,046.2 ± 2.0 MHz. The quoted uncertainty consists of three standard deviations for the statistical error plus estimates of systematic errors. This result agrees with the previous experimental values for $\mathcal{S}$ (within three standard deviations) and with the latest theoretical value of 14,044.5 ± 5.2 MHz. (auth)

38142 FINE STRUCTURE AND DIAMAGNETIC ZEEMAN EFFECT IN He(4^3P). Miller, T. A.; Freund, R. S. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., A; 4: No. 1, 81-90(1 Jul 1971).

The 4^3P state of helium was excited and aligned by electron impact in a strong magnetic field. Transitions between Zeeman levels of the fine-structure states are induced by microwave frequency radiation and are detected through the resulting change in polarization of 3188-Å fluorescence. The derived values of the fine-structure intervals are $4^3P_0-4^3P_1 = 3306.6 \pm 1.0$ MHz and $4^3P_1-4^3P_2 = 270.7 \pm 0.8$ MHz. The diamagnetic Zeeman interaction produces an observable effect, and the magnitude of its anisotropic part has been measured. The atomic radius and quadrupole moment are derived from this measurement and agree within experimental error with the values for a hydrogenic 4p orbital. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 38570, 38590, 38794, and 39114.

Collision Phenomena

Refer also to abstracts 38061, 38168, 38815, 38853, and 38929.

38143 (BNWL-SA-3853) ENERGY TRANSFER TO ELECTRONS IN FAST PROTON COLLISIONS. Toburen, L. H.; Glass, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 28 Apr 1971. Contract AT(45-1)-1830. 18p. (CONF-710508-2). Dep. NTIS.

From nineteenth annual meeting of the radiation research society; Boston, Mass. (9 May 1971).

Measurements were made of the energy and angular distributions of electrons ejected by impact of fast protons on thin gas targets. Cross sections for energy transfer to electrons were obtained. The effect of increasing the complexity of the target molecule is pointed out by comparison of results for protons on H_2 and on N_2. The interaction of protons with more complex molecules yields a wider spread in the angular distribution of energy transfer. For molecules having inner electronic shells, electrons ejected from the outer shells result in energy transfer distributions similar to those from hydrogen, and the more tightly bound electrons contribute to energy transfer in a more forward direction. In both H_2 and N_2 the angular dependence of the energy transfer to electrons is a strong function of the incident-proton energy. (A.G.W.)

38144 (NYO-2101-27) KINETIC ENERGIES OF IONIZATION PRODUCTS FROM COLLISIONS OF Ar–Ar, He–He BELOW 220 eV c.m. ENERGY. Hammond, R. H.; Henis, J. M. S.; Greene, E. F. (Brown Univ., Providence, R. I. Metcalf Chemical Lab.); Ross, John (Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry). [1970]. 31p. Dep. NTIS.

Measurements were made of the energy spectra of ions and electrons produced in the collision of beams of neutral Ar of given energy (laboratory energy range 57 to 240 eV) with a gas of Ar and of neutral He (145 to 300 eV) with a gas of He. The energy dependence of the total cross section for ionization is consistent with previous results. The electron spectra from collisions of Ar + Ar show peaks at 0, 6, and ~9 eV. From this it is estimated that about 15% of the Ar^+ ions produced come from autoionizing states of Ar. For certain ranges of initial relative energy Ar–Ar ionization occurs mostly in backscattering collisions. An analysis of the ion spectra of experiments at these initial relative energies (greater than 33 eV), made with a simple model, shows that most ions are produced by two curve crossings 12 ± 2 and 22 ± 1 eV above the ionization potential (15.8 eV). (auth)

38145 CURVE CROSSING IN SINGLE-ELECTRON-CAPTURE COLLISIONS. Hasted, J. B.; Iqbal, S. M.; Yousaf, M. M. (Birkbeck Coll., London. University Coll., London). J. Phys., B (London); 4: 343-64(1971).

Differential single-electron-capture probabilities P are reported for collisions of C^{2+}, N^{2+}, and O^{2+} ions with He, Ne, and Ar in the energy range 1 to 3 keV. They are analysed in terms of the impact parameter b and compared with calculations of Bates et al. (1964). P(b) is an oscillating function falling to zero outside $b = r_x$, the calculated nuclear separation of pseudo-crossing of potential

energy curves. This is used as a diagnostic of curve-crossing situations, especially those involving coupling to excited states. (auth) (UK)

38146 DIFFERENTIAL SCATTERING WITH CHARGE TRANSFER TO THE 2s STATE OF HYDROGEN FROM H^+–He AND H^+–Ar COLLISIONS. Crandall, David Hugh. Lincoln, Neb.; Univ. of Nebraska (1970). 187p. University Microfilms Order No. 71-9551.

Thesis.

For collisions of protons with helium and argon target gases, the differential cross sections for total scattering, the probabilities of charge transfer forming a hydrogen atom, and the probabilities of charge transfer forming a hydrogen atom in the 2s states were measured. The measurements were differential in the angle at which the incident particle was scattered. Scattering angles between 1° and 7° were used. The measurements were made for the range of incident proton energies between 3 and 20 keV. (TSS) (Diss. Abstr. Int., B)

38147 CALCULATION OF PRIOR- AND POST-TRANSITION AMPLITUDES IN THE VPS APPROXIMATION FOR ELECTRON COLLISION EXCITATION (2s → 2p) WITH LITHIUM. Felden, Madeleine (Univ., Nancy). Compt. Rend., Ser. B; 272: No. 12, 701-4(22 Mar 1971). (In French).

Excitation cross sections 2s → 2p associated with electron collisions with lithium atoms are determined in the Vainshtein–Presnyakov–Sobelman approximation. Bates and Damgaard atomic wave functions are used. The divergence is also discussed. (auth) (France)

38148 STIMULATED EMISSION FROM THE FIRST AND SECOND POSITIVE SYSTEMS OF N_2 BY PULSED RADIOLYSIS. Clerc, Michel; Schmidt, Michel (CEA, Saclay, France). Compt. Rend., Ser. B; 272: No. 11, 668-71(15 Mar 1971). (In French).

Population inversions in electronic transitions with very short radiative lives were produced by short-duration (3-nsec) pulses of electrons at 560 keV. Stimulated optical emission in the first and second positive nitrogen systems was then observed. (auth) (France)

38149 s-WAVE ELASTIC POSITRON–HYDROGEN SCATTERING IN THE IONIZATION REGION. Doolen, Gary (Texas A and M Univ., College Station); McCartor, Gary; McDonald, F. A.; Nuttall, J. Phys. Rev., A; 4: No. 1, 108-11(1 Jul 1971).

The method of extrapolating the t matrix from complex energies to real energies is tested on the positron–hydrogen s-wave amplitude at 29 energies in the elastic and inelastic regions, including 10 energies in the ionization region. The error in the extrapolated t matrix is not expected to be more than 10% in the ionization region. (auth)

38150 ELECTRON-IMPACT EXCITATION OF AUTO-IONIZING LEVELS IN CESIUM. Hahn, Yu Bong; Nygaard, Kaare J. (Univ. of Missouri, Rolla). Phys. Rev., A; 4: No. 1, 125-32 (1 Jul 1971).

Auto-ionizing states in Cs between 12 and 20 eV were studied by electron impact. The retarding-potential-difference method was used to obtain an electron beam with energy spread of about 0.1 eV. To determine the threshold energies, inelastically scattered electrons were analyzed by the trapped-electron method. About 20 levels were identified, and the agreement with spectroscopic data is excellent. A peak appearing at 12.80 eV is probably due to the quartet states observed by Feldman and Novick. (auth)

38151 ENERGY SHIFTS OBSERVED IN Ni K X RAYS PRODUCED BY FISSION-FRAGMENT COLLISIONS. Watson, R. L.; Li, T. K. (Texas A and M Univ., College Station). Phys. Rev., A; 4: No. 1, 132-6(1 Jul 1971).

The $K\alpha$ and $K\beta$ x rays of Ni produced by the passage of light fission fragments from the spontaneous fission of ^{252}Cf through a thin Ni foil were found to be shifted up in energy by 69 ± 11 and 210 ± 16 eV, respectively, relative to the x rays produced by 6-MeV α particles and by photons from the decay of ^{241}Am. These shifts are similar in character to those observed previously in 15-MeV oxygen-ion bombardments, but require extremely high ionic charge states to be explainable in terms of multiple inner-shell plus outer-shell ionization. (auth)

38152 CHARGE-TRANSFER EXCITATION OF Ar^+ IN LOW-ENERGY He^++Ar COLLISIONS. Lipeles, Martin (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Rev., A; 4: No. 1, 140-6(1 Jul 1971).

An experimental study was made of the excitation of the Ar II spectrum in low-energy (10 to 1000 eV) He^+ + Ar collisions. The principal states excited, which have lines from 3500 to 5200 Å, were positively identified. The dependence of excitation on energy was measured for six states. It was found that states with ^1D parent terms are generally stronger and have more rapid rise with energy at threshold than states with ^3P parent terms. The effect of cascade from higher excited states on the intensities of the strongest lines was studied. The energy dependence of one state is compared with the form expected from a simple Landau–Zener model. (auth)

38153 INELASTIC-ELECTRON-SCATTERING CROSS-SECTION MEASUREMENTS AT 0.2-, 1.0-, AND 2.0-MeV INCIDENT ELECTRON ENERGIES. Rester, D. H. (Advanced Technology Center, Inc., Dallas, Tex.); Edmonson, N. Phys. Rev., A; 4: No. 1, 147-51(1 Jul 1971).

Spectra of inelastically scattered electrons from Al and Au targets are shown for scattering angles of 45° and 135° at incident electron energies of 0.2, 1.0, and 2.0 MeV and for an angle of 60° at an energy of 1.0 MeV. Theoretical values from the Bethe–Heitler theory, calculated from the formulas of McCormick, Keiffer, and Parzen, are compared to the measured values. (auth)

38154 SENSITIVITY OF RAINBOW STRUCTURE IN PROTON–HELIUM ELASTIC SCATTERING TO SMALL CHANGES IN THE POTENTIAL SURFACE. Riley, Merle E. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., A; 4: No. 1, 151-3(1 Jul 1971).

The proton-on-helium elastic-scattering differential cross section is computed through the rainbow region for two different potential surfaces, each of high accuracy, for center-of-mass energies 92.7 and 15.4 eV (115.8 and 19.3 eV in the lab frame) to test an assumption that the semiclassical approximation would give adequate information at the rainbow angle to distinguish experimentally the better of the theoretical potentials. (auth)

38155 ENERGY SPECTRA OF METASTABLE OXYGEN ATOMS PRODUCED BY ELECTRON-IMPACT DISSOCIATION OF O_2. Borst, Walter L.; Zipf, E. C. (Univ. of Pittsburgh). Phys. Rev., A; 4: No. 1, 153-61(1 Jul 1971).

Kinetic energies of metastable O atoms formed in dissociative excitation of O_2 were measured by a time-of-flight experiment. Metastable $O(^5S^0)$ atoms (9.14 eV) as well as high-lying states near the ionization limit of O (13.6 eV) were detected by means of Auger ejection of secondary electrons from a Cu–Be surface. The energy spectra of metastable fragments showed distinct structure with maxima near 0.3 and 2 eV. Repulsive-potential-energy curves of O_2 were constructed from the measured energy spectra and time-resolved excitation functions. The excitation function for the direct excitation of the $O(^5S^0)$ state had a threshold of 14.3 ± 0.2 eV, which is equal to the minimum energy for dissociatively exciting the $O(^5S^0)$ state. Using selection rules and symmetry arguments concerning the angular variation of dissociation products, the molecular state reached near 14.3 eV was identified as a Π_u state with a probable multiplicity of 3. Other molecular states reached at higher energies were not identified. It seems, however, that there was a sizable contribution due to O atoms in high-lying Rydberg states excited in dissociative excitation. The differential cross section for the direct formation of $O(^5S^0)$ was found to be $d\sigma/d\Omega \simeq 1 \times 10^{-19}$ cm²/sterad within a factor of 2 at an electron energy of 30 eV and an angle of 90° with respect to the electron beam. Several atmospheric applications of the measurements concerning the heating of the atmosphere, radiative transfer of resonance radiation, and chemical reactions are mentioned briefly. (auth)

38156 CHARGE-TRANSFER COLLISIONS INVOLVING ELECTRON TRANSFER TO EXCITED STATES. Perel, Julius; Daley, Howard L. (Electro-Optical Systems, Pasadena, Calif.). Phys. Rev., A; 4: No. 1, 162-71(1 Jul 1971).

A crossed-beam technique was used to measure total nonresonant charge-transfer cross sections of the following reactions over an energy range from about 0.5 to 20 keV: $Li^+ + Cs \rightarrow Li + Cs^+$, $Li^+ + Rb \rightarrow Li + Rb^+$, $Li^+ + K \rightarrow Li + K^+$, $Hg^+ + Cs \rightarrow Hg + Cs^+$. For each reaction, the minimum energy defect occurs for transfer to an excited state. The cross sections show typical nonresonant characteristics with the measured maxima corresponding to these energy defects. The production of photons resulting from deexcitation of the Li (2p) state formed by charge-transfer collisions was also measured over the same energy range for the reactions involving Li. These photon cross sections (with larger experimental uncertainties than the total cross sections) were "normalized" to the total cross section in the near-adiabatic region using semiempirical relationships. Transfer to an excited state is the dominant channel in the near-adiabatic region with transfer to the ground state becoming increasingly important with increasing impact velocity. The discussion of

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the $Hg^+ + Cs$ results includes statistical weight considerations. (auth)

38157 LOW-ENERGY ELASTIC AND FINE-STRUCTURE-EXCITATION SCATTERING OF GROUND-STATE C^+ IONS BY HYDROGEN ATOMS. Weisheit, Jon C.; Lane, Neal F. (Rice Univ., Houston, Tex.). Phys. Rev., A; 4: No. 1, 171-82(1 Jul 1971).

Cross sections are computed for the elastic and fine-structure-excitation scattering of singly ionized carbon atoms by low-energy (less than 0.1 eV) hydrogen atoms. A close-coupling formulation is employed, and the scattering equations are solved in a coupled-angular-momentum representation. The correct energy defect between the $C^+(^2P)$ fine-structure levels is included. For the first time, both spin-change and long-range electrostatic coupling terms are explicitly included in the scattering equations. The calculated C^+-H excitation cross section varies from 4.87×10^{-15} cm^2 at 0.01 eV to 2.86×10^{-15} cm^2 at 0.085 eV, and the maximum of almost 5.60×10^{-15} cm^2 occurs near 0.015 eV. The spin-change coupling, described herein, is found to be much more important than the long-range electrostatic coupling at all energies considered. (auth)

38158 ELECTRON-IMPACT EXCITATION OF THE RARE GASES. Ganas, P. S.; Green, A. E. S. (Univ. of Florida, Gainesville). Phys. Rev., A; 4: No. 1, 182-93(1 Jul 1971).

The analytic atomic independent-particle model (IPM) of Green, Sellin, and Zachor was used as a basis for calculating generalized oscillator strengths for the single-particle excitations of Ne, Ar, Kr, and Xe. First, averages of the experimental energy levels were established to arrive at single-particle states. The two parameters were then adjusted so that the IPM potentials accurately characterized these excited-state energies. The wave functions associated with these potentials and the Born approximation were used to calculate the generalized oscillator strengths for excitations to p^5ns states. A very complex nodal structure is apparent at large values of momentum transfer, and a rapid decline in magnitude occurs after the second node. The results up to the second node may be accurately characterized by a convenient analytic form that leads to analytic total excitation cross sections. Available optical oscillator strengths were used to normalize the results. The systematics and regularities of the parameters for various Rydberg series are discussed and approximate scaling laws are given. (auth)

38159 DISTORTED-WAVE CALCULATION OF ELECTRON-IMPACT EXCITATION OF THE RARE GASES. Sawada, T.; Purcell, J. E.; Green, A. E. S. (Univ. of Florida, Gainesville). Phys. Rev., A; 4: No. 1, 193-203(1 Jul 1971).

A distorted-wave (DW) formulation with exchange is given for the electron-impact excitation of the rare gases from $(n_0p)^6$ to $(n_0p)^5nl$ configurations. A practical form employing the pure LS-coupling scheme is used in conjunction with the phenomenologically determined independent-particle model (IPM) and the DW potentials of real central forms to compute cross sections averaged over fine structures. Numerical work is carried out for Ne $2p \rightarrow 3s$ and Ar $3p \rightarrow 4s$ electron-impact excitations. The distorted generalized oscillator strengths (DGOS), which converge to the generalized oscillator strengths (GOS) in the limit of the Born approximation, as well as integrated cross sections, are obtained over a wide range of energies, so that the systematic variation of the cross sections in relation to the results of the Born approximation can be studied. The results of the angular distributions at lower energies are in reasonable agreement with the data by Nicoll and Mohr. (auth)

38160 OPTICAL POTENTIAL FOR THE ROTATIONAL EXCITATION OF DIATOMIC MOLECULES BY ATOMS. Rotenberg, Manuel (Univ. of California, San Diego, La Jolla). Phys. Rev., A; 4: No. 1, 220-5(1 Jul 1971).

By restricting attention to a single open scattering channel at a time, it is found that an optical potential, accurate to second order in the scattering potential, can be easily derived for the example of rotational excitation of a rigid rotator by a structureless atom. The resulting equations are contrasted with those derived from the close-coupling method. In cases where many open channels are present, the optical-potential method seems to offer many advantages over close coupling. Various practical methods for improving the accuracy of the optical potential beyond second order are discussed. (auth)

38161 EQUILIBRIUM CHARGE-STATE DISTRIBUTIONS OF HEAVY IONS (1 TO 14 MeV). Wittkower, A. B.; Ryding, G. (High Voltage Engineering Corp., Burlington, Mass.). Phys. Rev., A; 4: No. 1, 226-32(1 Jul 1971).

Equilibrium charge-state distributions were determined experimentally for chlorine and bromine ions with energies between 1 and 14 MeV traversing H_2, He, N_2, O_2, Ar, and Kr gases and a carbon foil. In addition, a few measurements were made using iodine beams traversing various targets—at 3, 10, and 12 MeV through carbon foil, at 8 MeV through CO_2, at 10 and 12 MeV through gold foil, and at 12 MeV through a Xe gas target. (auth)

38162 CHARGE-EXCHANGE COLLISIONS BETWEEN NEGATIVE HYDROGEN IONS AND CESIUM VAPOR IN THE ENERGY RANGE 2 TO 30 keV. Leslie, T. E.; Sarver, K. P.; Anderson, L. W. (Univ. of Wisconsin, Madison). Phys. Rev., A; 4: No. 1, 408-10(1 Jul 1971).

Charge-exchange collisions of H^- ions in a Cs vapor target were studied for incident H^- energies of 2 to 30 keV. The cross sections σ_{-0} and σ_{+} were obtained. The cross section σ_{-0} has the value $(2.1 \pm 0.3) \times 10^{-15}$ cm^2 at 5 keV and decreases slowly as the energy increases. The cross section σ_{+} has the value $(2.4 \pm 0.3) \times 10^{-17}$ cm^2 at 5 keV and increases rapidly as the energy increases. (auth)

38163 POLARIZATION AND EXCHANGE EFFECTS IN LOW-ENERGY-ELECTRON-D_2 SCATTERING. Henry, Ronald J. W. (Louisiana State Univ., Baton Rouge); Lane, Neal F. Phys. Rev., A; 4: No. 1, 410-11(1 Jul 1971).

Exchange and polarization effects are included in an $e-D_2$ interaction potential. Cross sections for rotational excitation by electron impact for energies less than 1.0 eV are calculated for $0 \rightarrow 2$, $1 \rightarrow 3$, and $2 \rightarrow 4$ transitions in D_2. For energies less than 0.5 eV, theoretical results are found to be in agreement to within 8% with results deduced from swarm experiments by Gibson. (auth)

38164 FORMATION OF CHARGED AND EXCITED PARTICLES IN COLLISIONS OF He^+, Ne^+, AND Ar^+ IONS WITH CO MOLECULES. Gusev, V. A.; Polyakova, G. N.; Erko, V. F.; (and others) (Physical-Tech. Inst., Kiev). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1597-1603(May 1971). (In Russian).

The total effective cross sections for formation of CO^+, C^+, and O^+ ions produced in collisions of He^+, Ne^+, and Ar^+ ions (ion energy 3 to 50 keV) with CO molecules were measured by the mass-spectrometer technique. The spectroscopic technique was employed for measuring the effective cross sections for formation of excited CO^+, C^+, and O^+ ions in similar collisions (ion energy 0.12 to 30 keV). From the results of the measurements it was concluded that many features of the $\sigma(v)$ curve (σ is the effective cross section for a certain collision process and v is the relative velocity of the colliding particles) can be explained by the adiabatic maximum rule. In the low-energy range, the curves are found to deviate from those expected on the basis of Massey's adiabatic hypothesis. (auth)

Atomic Theory

Refer also to abstract 38618.

38165 EFFECTS OF CONFIGURATION INTERACTION ON ATOMIC HYPERFINE STRUCTURE. Bauche-Arnoult, Claire (Johns Hopkins Univ., Baltimore). Proc. Roy. Soc. (London), Ser. A; 322: No. 1550, 361-76(4 May 1971).

The effects of configuration interaction on hyperfine structure (hfs) are considered using second-order perturbation theory. Within a given LS term these are represented by multiplying the radial quantity $\langle r^{-3} \rangle$ for each of the three orbit-dependent parts of the hfs hamiltonian by a different factor $(1 + \Delta)$. The analysis is limited to those configurations in which the only electrons not in closed shells are those of the type $(nl)^N$. Separate treatment is given to the excitation of (1) a closed-shell electron into an unoccupied shell $n'l'$, (2) an electron nl into an unoccupied shell $n'l'$, and (3) a closed-shell electron into the occupied shell nl. Effective operators are introduced. In cases (2) and (3), where the quantities Δ_1, Δ_{sC}, and Δ_q (corresponding to the three parts of the hfs hamiltonian) depend on the LS term under study, some tables are given for d^N and f^N from which it is possible to make predictions concerning the effects of configuration interaction on the three parts of the effective hfs hamiltonian without requiring a detailed knowledge of radial integrals. Results consistent with the experimental data for the 3d shell are obtained. The effects of departures from perfect LS coupling are discussed. (auth) (UK)

38166 SPONTANEOUS EMISSION IN SEMICLASSICAL RADIATION THEORY. Nesbet, R. K. (IBM Research Lab., San Jose, Calif.). Phys. Rev., A; 4: No. 1, 259-64(1 Jul 1971).

It has recently been shown by Jaynes and collaborators that semiclassical radiation theory contains a description of spontaneous emission of radiation and of radiative level shifts. The

present paper gives a gauge-invariant derivation of the radiant-energy production rate, using only Maxwell's equations and the usual definitions of electric current and charge density for a many-particle material system described by Schrödinger's equation. A complementary derivation, using the time-dependent Schrödinger equation, verifies the instantaneous conservation of energy and probability during the radiation process. The semiclassical rate of spontaneous emission differs from the usual formula (Einstein's A coefficient) because it depends on the occupancy of both initial and final states of the material system. The implications of this with regard to thermal equilibrium and Planck's law are examined. If a new hypothesis is introduced, postulating the decomposition of the equilibrium radiation into incoherent components, each interacting with a specific pair of energy levels of the material system, then Planck's law is shown to hold for the total intensity of radiation. If this hypothesis is not introduced, the equilibrium conditions for different transitions are incompatible, and the semiclassical radiation theory is incapable of describing thermal equilibrium. (auth)

38167 QUANTUM STATISTICAL THEORY OF SUPERRADIANCE. I. Bonifacio, R. (Univ., Milan); Schwendimann, P.; Haake, Fritz. Phys. Rev., A; 4: No. 1, 302-13(1 Jul 1971).

The cooperative decay of initial atomic excitation for a pencil-shaped active volume filled with two-level atoms is discussed. As long as the length of the sample is much smaller than a certain maximal cooperation length, the atom–field interaction producing the superradiant pulse can be treated in terms of the simplest possible laser model (single mode). The basic laser master equation turns out to be exactly solvable if specified for the superradiance limit characterized by two conditions: (1) The photons escape from the low-Q cavity so fast that they cannot feed themselves back into atomic excitation to any appreciable amount (this no-feedback condition is equivalent to the above-mentioned requirement for the length of the sample). (2) The incoherent atomic decay due to natural relaxation is so slow that the individual atomic dipoles do not dephase before engaging themselves cooperatively in the interaction with the electromagnetic field. The present paper presents the derivation and general discussion of the equations describing the statistical properties of atoms and field in a superradiant pulse. Analytical and numerical solutions will be presented in a subsequent paper. (auth)

38168 TWO ELECTRONS IN A COULOMB POTENTIAL. DOUBLE-CONTINUUM WAVE FUNCTIONS AND THRESHOLD LAW FOR ELECTRON–ATOM IONIZATION. Rau, A. R. P. (Univ. of Chicago). Phys. Rev., A; 4: No. 1, 207-20(1 Jul 1971).

The Schrödinger equation for two electrons in a Coulomb field is studied in the critical region where both electrons have near-zero kinetic energies. The main feature of this problem is that the mutual screening between the two electrons determines and is determined by the partition of the available energy between them. This energy-dependent screening can be taken into account to yield a complex potential in the radial variable $R = (r_1^2 + r_2^2)^{\frac{1}{2}}$ of the six-dimensional configuration space of the two electrons. Solutions of this equation are obtained and are shown to correspond to the classical orbits given in an early paper by Wannier. A possible way is indicated of using these wave functions to establish the Wannier threshold law, which, for ionization of neutral atoms, is $\sigma \propto E^{1.127}$. Finally, the interplay between the total energy and the Coulomb potential is discussed both for this problem and for the case of one electron in the field of a nucleus. (auth)

38169 BREIT INTERACTION IN MULTIELECTRON ATOMS. Mann, Joseph B. (Los Alamos Scientific Lab., N. Mex.); Johnson, Walter R. Phys. Rev., A; 4: No. 1, 41-51(1 Jul 1971).

The Breit interaction is reviewed with applications to heavy atoms in mind. Generalizations of the Breit interaction which avoid expansion in powers of the electron velocities are discussed. Two-particle matrix elements of the Breit interaction and its generalizations are given in a form convenient for numerical applications. Expressions are derived for evaluating configuration-averaged atomic energy shifts for the Breit interaction and its generalizations. Numerical results for the energy shifts of atomic ground states are presented for selected atoms in the range Z = 2 to 102; interpolated values of the energy shifts are given graphically for all atoms in the range considered. A breakdown of the interelectron contributions to the Breit energy shift is given for Ne and for K electrons in Hg. "Frozen-orbital" calculations of Breit corrections to electron binding energies in Hg are given. The binding energies of K electrons in W, Hg, Pb, and Rn including the generalized Breit interaction with rearrangement are determined; when considered together with Lamb shift and correlation effects, these calculations reduce the discrepancy between theoretical and experimental K binding energies to about 0.1 rydberg. (auth)

38170 HYDROGENIC ATOMS IN A MAGNETIC FIELD. Grotch, H. (Pennsylvania State Univ., University Park); Hegstrom, Roger A. Phys. Rev., A; 4: No. 1, 59-69(1 Jul 1971).

The interaction of hydrogenic atoms with a weak constant magnetic field is discussed in detail. The Breit Hamiltonian, minimally coupled to the external magnetic field, is treated in several different ways. First, approximate eigenfunctions are obtained in the nonrelativistic nucleus approximation. These wave functions are used to treat perturbatively the residual terms dependent on the magnetic field and to identify the magnetic moment of the bound electron in the ground state. The corrections previously given by the authors, of relative order $(Z\alpha)^2$, $(Z\alpha)^2 m/M$, $\alpha(Z\alpha)^2$, and $\alpha(Z\alpha)^2 m/M$, are confirmed including lowest-order radiative corrections. Next, a unitary transformation of the complete Breit Hamiltonian is made in order to simplify further the calculation of small corrections to the electron and nuclear g factors. The physical origin of this unitary transformation, which is similar to a gauge transformation, is discussed extensively, and it is shown that the transformed Hamiltonian for a neutral system commutes with $\vec{P}$, the momentum conjugate to the center-of-mass position $\vec{X}$. This new Hamiltonian, which treats the electron and the nucleus on equal footing, is then transformed by means of the Chraplyvy–Barker–Glover reduction. The electron and the nuclear g factors are calculated, this time including terms of relative order $(Z\alpha)^2 m^2/M^2$ and $\alpha(Z\alpha)^2 m^2/M^2$. These computations yield the magnetic moments for hydrogenic atoms in their ground state. The theoretical results are summarized and compared with recent experiments. (auth)

38171 RADIATIVE SHIFT OF THE RADIATION FREQUENCY IN A RESONANCE MEDIUM. Sokolovskii, R. I. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1611-13(May 1971). (In Russian).

The radiative frequency (Lamb) shift of the radiation from an atomic system in a resonant medium is studied. It is shown that the corrections are important for standards with a frequency reproducibility of 10^{13} or higher. (auth)

38172 APPROXIMATE RELATIVISTIC CORRECTION TERM. Huzinaga, Sigeru; Arnau, Catalina (Univ. of Alberta, Edmonton). Mol. Phys.; 20: No. 5, 895-8(May 1971).

It is demonstrated that the first-order relativistic correction term to the Schrödinger Hamiltonian for the hydrogen-like atom, $R = (\pi/2)\,\alpha^2 Z\delta(r) - \frac{1}{8}\,\alpha^2\Delta^2$, cannot be used safely even for small values of atomic number, Z, in the variational calculation. A modified form of the operator R is proposed so that it may be incorporated into the variational treatment of molecular systems. (auth)(UK)

Cosmic Radiation

Refer also to abstracts 38059, 38125, 38210, 38214, 38631, 38645, 38653, 38686, and 38687.

38173 (UCRL–20209) AN EXPERIMENTAL MEASUREMENT OF GALACTIC COSMIC RADIATION DOSE IN CONVENTIONAL AIRCRAFT BETWEEN SAN FRANCISCO AND LONDON COMPARED TO THEORETICAL VALUES FOR CONVENTIONAL AND SUPERSONIC AIRCRAFT. Wallace, Roger; Boyer, Michael F. (California Univ., Berkeley. Lawrence Radiation Lab.). 25 Feb 1971. Contract W-7405-eng-48. 23p. (CONF-710304–11). Dep. NTIS.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev (1 Mar 1971).

By utilizing beta–gamma and NTA photographic emulsions and thermoluminescent dosimeters, measurements of radiation dose were made in conventional jet aircraft between San Francisco and London. These direct measurements were in fair agreement with computations made using a program that takes into consideration both basic cosmic-ray atmospheric physics and the focusing effect of the Earth's magnetic field. These measurements also agreed with those made at supersonic jet aircraft altitudes in RB-57 aircraft. It was concluded that both experiments and theory show that the doses received at conventional jet aircraft altitudes are slightly higher than those encountered in supersonic flights at much higher altitudes, when the longer time of exposure at the lower altitudes is taken into consideration. (auth)

38174 COSMIC NOISE ABSORPTION MEASUREMENTS IN DELHI. Sarma, S. B. S. S.; Sharma, M. C.; Juneja, S. L. (National Physical Lab., New Delhi). Indian J. Pure Appl. Phys.; 8: 529-32(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

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The results of cosmic-noise absorption measurements at 20 and 30 MHz over Delhi during the period 1963 to 1966 are presented. The results indicate large diurnal, seasonal, and solar-cycle variations. The strong dependence of the cosmic-noise absorption on f_0F_2 and total electron content establishes that major contribution in total absorption comes from the F region. (auth)

38175 PROPAGATION OF COSMIC RAYS IN THE SOLAR WIND. Jokipii, J. R. (California Inst. of Tech., Pasadena). Rev. Geophys. Space Phys.; 9: 27-87(Feb 1971).

A coherent exposition of modern statistical theory of transport of fast charged particles (cosmic rays) in the solar wind is presented. Observations are discussed, and the historical development of the theory is followed. The dominant effect on the motion of cosmic rays in the solar wind is the interplanetary magnetic field, which is irregular and which is, therefore, best treated statistically, using random functions. The magnetic irregularities scatter the cosmic rays in pitch angle so that, to a good approximation, the cosmic rays diffuse through the irregular magnetic field. Using a statistical analysis of the equations of motion, one may relate the diffusion tensor to the power spectrum of the magnetic field which is, in principle, measurable. The resulting general transport theory relates the motion of cosmic rays, statistically, to the solar-wind velocity and magnetic field. Application of the theory both to modulation of galactic cosmic rays by the solar wind and to propagation of solar cosmic rays is discussed. (auth)

38176 ZENITH-ANGLE DISTRIBUTION OF ATMOSPHERIC MUONS ABOVE 1 TeV. Flatte, S. M. (Univ. of California, Berkeley); Decoster, R. J.; Stevenson, M. L.; Toner, W. T.; Zipf, T. F. Phys. Lett.; 35B: No. 4, 345-50(7 Jun 1971).

The flux of atmospheric muons as a function of momentum and zenith angle is measured for $p > 0.3$ TeV and $60° < \theta < 87°$. Special attention is given the angular distribution above 1 TeV. (auth)

38177 SINGULARITIES OF THE LATERAL DISTRIBUTION OF RADIO EMISSION OF EXTENSIVE AIR SHOWERS. Atrashkevich, V. B.; Vedeneev, O. V.; Khristiansen, G. B. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.); 13: No. 2, 51-4 (20 Jan 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 2, 76-80(20 Jan 1971).

A system of half-wave dipoles was employed to observe the lateral distribution of the radio emission in individual showers in a range of distances from 25 to 400 m from the shower axis. Although the spatial distribution of the radio emission in each individual shower was described by a smooth function, the form of this function fluctuated strongly from shower to shower. (W.D.M.)

38178 ZENITH-ANGLE DEPENDENCE OF COSMIC-RAY MUONS. Bolingbroke, Gerald Lynn. Salt Lake City, Utah; Univ. of Utah. 93p. University Microfilms Order No. 71-13,424.

Thesis.

The zenith-angle distribution of high-energy cosmic-ray muons was investigated using a large sample of 1.95×10^5 muons and a new method of analysis that is insensitive to the parameters of cosmic-ray phenomenology. The detector efficiency was measured in great detail during the same runs used for obtaining the muon intensities. The results provide strong evidence for an isotropic component to the muon spectrum. This component appears to have a threshold at about 1 TeV muon energy and to go through a broad maximum in the vicinity of 2.4 TeV, where the ratio, f_X, of isotropic component to total muon intensity was 0.55 ± 0.05. Models with different fractions of kaons were tried to fit the data. In all cases an isotropic component was needed to give the best fit, but a larger kaon component required an f_X about half as large. Detailed tests were made to check systematic errors in the rock and the efficiencies. No indications of systematic errors large enough to permit an interpretation in terms of the conventional production mechanisms were found. (Diss. Abstr. Int., B)

38179 PROPAGATION OF COSMIC-RAY NUCLEI. Pacheco, J. A. de Freitas (Observatoire, Nice). Astron. Astrophys.; 13: No. 1, 58-64(Jun 1971).

The transfer equation for particles is solved for a very simple model, taking into account the boundary conditions. The diffusion coefficient obtained in the calculations is about two or three orders of magnitude smaller than the usual value. The lifetime of M nuclei in the Galaxy is smaller than the time required to diffuse out from the Galaxy and smaller than the nuclear destruction time. Only for protons is the lifetime essentially equal to the diffusion time. (auth)

38180 SEARCH FOR COSMIC DUST. SOLAR COSMIC-RAY EFFECTS WITHIN LUNAR SAMPLES. Delany, Anthony Charles. San Diego, Calif.; Univ. of California (1970). 137p. University Microfilms Order No. 71-12,437.

Thesis.

In part 1, a continuous day-by-day collection was maintained for a year at a ground-level station in the Tradewind belt. A 40-m wooden tower at the most windward point of the island of Barbados allowed collection meshes to be suspended in the pure oceanic air. Fine terrestrial dust from the trans-Atlantic land masses made the search for <10 μm impossible. However, because of the extremely low magnetic component of these dusts, an upper limit on the amount of extraterrestrial magnetic material could be set as <0.2 tons earth^{-1} day^{-1}. A complementary balloon-borne sticky-mesh collection system operated in the low stratosphere gave results which indicated that the total influx to the Earth was <500 tons Earth^{-1} day^{-1}. In Part 2, samples of lunar rock and soil were investigated to determine the induced radioactivity record of the solar and the galactic cosmic rays. Different activities were measured as they varied with depth in an effort to define the free-space solar and galactic cosmic-ray fluxes for the periods corresponding to the mean life of the isotope considered. Activity profiles derived for different intensities and hardness using a mathematical model were graphically compared with the experimental points to give best values of intensity and hardness for each time period. (TSS) (Diss. Abstr. Int., B)

38181 SPECTRUM OF COSMIC-RAY NEUTRONS AT SEA LEVEL IN THE RANGE 0.4 TO 1.2 GeV. Ashton, F.; Edwards, H. J.; Kelly, G. N. (Univ. of Durham, Eng.). J. Phys., A (London); 4: No. 3, 352-66(May 1971).

The neutron spectrum at sea level was measured in the kinetic energy range 0.4 to 1.2 GeV, using the charge exchange reaction $n + p \rightarrow p + n$. In this energy range the vertical intensity of neutrons is found to be consistent with the value calculated from the work of Hughes and Marsden (1966) who estimated the global spectrum of neutrons from indirect measurements of the multiplicity distribution of neutrons in a neutron monitor. (auth) (UK)

38182 COSMIC-RAY SHOWERS PRODUCED BY MUON BREMSSTRAHLUNG. Kiraly, P.; Thompson, M. G.; Wolfendale, A. W. (Univ. of Durham, Eng.). J. Phys., A (London); 4: No. 3, 367-76(May 1971).

A number of groups have observed air showers in the atmosphere at large zenith angles, where the frequency of conventional air showers induced by primary nucleons is expected to be very small. In this work the possibility of explaining the showers in terms of muon bremsstrahlung is examined; the expected shower size spectrum for this process is calculated, and the method enables the sensitivity of shower frequency to high-energy muon intensity to be examined rather simply. Some problems associated with comparison of prediction with the experimental results are indicated. A tentative comparison indicates that, when allowance is made for the effect of uncertainties in recorded shower size, it is likely that the majority of the showers can be explained by muon bremsstrahlung. The possible exception is some of the events recorded by the Tokyo group in 1970 (Nagano et al.) which appear to have a higher penetrating-particle content than would be expected on the bremsstrahlung hypothesis. (auth) (UK)

38183 DENSITY OF GALACTIC COSMIC-RAY ELECTRONS. Setti, G. (Univ., Bologna); Woltjer, L. Astrophys. Lett.; 8: No. 3, 125-8(May 1971).

Current evidence points to interstellar magnetic fields of no more than 2 to 3 μG. Galactic cosmic-ray electrons with the same density as observed near the Sun produce insufficient synchrotron radiation to account for the galactic radio background. The possibility of resolving this difficulty is considered by assuming that the mean density of cosmic-ray electrons in the galaxy exceeds that near the Sun by an order of magnitude. In that case the 100-MeV γ rays from the galactic plane can be interpreted as Compton radiation from the same electrons, but x rays at 1 to 10 keV must have a different origin. Since it is unlikely that cosmic-ray protons have the same inhomogeneous distribution as the electrons, the electrons and protons probably come from different sources in this model. (auth)

38184 ACCELERATION OF COSMIC RAY PARTICLES BY PULSAR FIELDS. Kegel, Wilhelm H. (Univ., Heidelberg). Astron. Astrophys.; 12: No. 3, 452-5(Jun 1971).

The theory of Gunn and Ostriker (1969) of the acceleration of cosmic-ray particles in strong electromagnetic fields in the vicinity of pulsars is reviewed. This theory is based on the assumption that the electromagnetic field is a vacuum wave. Using

the plane wave approximation it is shown that refractive index effects become important if $\pi\alpha(2\delta)^{\frac{1}{2}} \gtrsim 1$ where δ gives the deviation of the refractive index from unity ($n = 1 - \delta$) and $\alpha = qE^0/em\omega$, q and m being the charge and the mass of the accelerated particle and E^0 and ω the amplitude and frequency of the electric field. With these results it seems questionable whether the highest energies observed in cosmic rays can be obtained in pulsar fields. (auth)

Direct Energy Conversion

Refer also to abstracts 38208, 38209, 38501, and 38502.

38185 GENERATING DUCT FOR A MAGNETOHYDRODYNAMIC ELECTRICAL GENERATOR. Mottram, Anthony William Thomas (to Rolls-Royce Ltd.). British Patent 1,180,217. 4 Feb 1970. Filed 15 Jul 1966.

A method is described for manufacturing a generator duct for an MHD generator by sealing securely together end-to-end alternate electrode-defining, annular, tubular members and annular layers of insulation. It comprises the steps of providing a first set of templates, each having a periphery of such a shape that the templates may be assembled alternately with template separators in a pack, forming a laminated block having a peripheral surface of the same shape as the inner periphery of the duct to be formed. Each template has a thickness equal to the intended axial thickness of a member and each template separator has a thickness equal to the intended axial thickness of an insulating layer. (M.H.R.)

38186 EFFECTS OF LEAKAGE CURRENTS TO THE GROUND IN AN MHD GENERATOR WITH UNIFORM GAS. Celinski, Z. Arch. Elektrotech. (Warsaw); 20: No. 1, 233-42 (1971).

The expressions are derived that determine the effects of leakage currents to ground upon the electrical performance of Faraday- and Hall-type MHD generators when the leakage resistance is distributed along the channel. The constant gas parameters and the constant channel cross section are assumed. The numerical calculation performed for a typical generator has shown that this effect is not too large when the insulation resistance between the electrode and the generator casing is of the order of several thousand ohms. (auth)

38187 IMPROVEMENT TO ELECTRODES FOR MAGNETOHYDRODYNAMIC CONVERTER. Devime, Robert; Ricateau, Pierre; Yerouchalmi, David (to Commissariat a l'Energie Atomique). British Patent 1,232,287. 19 May 1971. Priority date 27 Jun 1967, France.

The electrode described for the duct of an MHD converter is comprised of elements of a refractory oxide resting on a metallic support and has passages to supply the elements, during operation of the converter, with pure oxygen or oxygen-containing gases at the interface region between the refractory oxide and the metallic support. This improvement in the electrodes prevents them from being damaged by electrolysis. (M.H.R.)

38188 THERMODYNAMIC ANALYSIS OF COMMERCIAL THERMAL ELECTRIC POWER PLANTS INCLUDING AN MHD GENERATOR WITH AN INERT GAS FLOW SHIELDED CHANNEL. Osadchii, V. K.; Shchegolev, G. M. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 5, 978-82 (Sep-Oct 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 5, 1050-5(Sep-Oct 1970).

Results are presented from a thermodynamic analysis of oxygen-cycle thermal electric power stations incorporating an MHD generator with nitrogen-flow-shielded, perforated channel walls. (The nitrogen is a by-product of air separation in the oxygen plant.) It is shown that the system with gas injection has a thermal efficiency comparable to that for a system with external water cooling. Use of gas injection permits improvement of a number of construction characteristics in an MHD power plant installation. (auth)

38189 EXPERIMENTAL APPARATUS START FOR STUDYING AN MHD GENERATOR WORKING WITH INERT-GAS PLASMA INCORPORATING AN ALKALI METAL ADDITIVE. Buznikov, A. E.; Vanin, V. E.; Kirillov, V. V.; Sokolov, Yu. N. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 5, 991-8(Sep-Oct 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 5, 1064-72(Sep-Oct 1970).

A long-acting experimental apparatus operating in conjunction with an MHD generator working in an argon–potassium plasma is described, together with its fundamental circuitry, and also the function and construction of the principal components and systems. Some experimental results are presented in relation to the operation of individual parts of the circuit. Several constructions of MHD-generator channels are described, together with the corresponding test results. (auth)

Fluid Physics

38190 APPROXIMATE SOLUTION OF THE FLOW OF A CONDUCTING FLUID IN A RECTANGULAR CHANNEL. Regirer, S. A. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 5, 33-40 (Sep-Oct 1970). (In Russian).

An analytical solution was developed for the steady-state flow of a viscous, incompressible fluid with a finite isotropic conductivity in a rectangular duct in the presence of an external magnetic field applied perpendicularly to the nonconducting walls. The results are presented on the flow in ducts with two electrodes parallel to the field and with four nonconducting walls. An examination of the asymptotic behavior of the solution for large Hartmann numbers and the experimental data obtained revealed that there is a small difference between the flow in a duct with four nonconducting walls and one with two electrodes and two nonconducting walls when the external electric circuit is interrupted. The pertinent literature is also reviewed. (23 reference) (TTT)

38191 APPLICATION OF BAECKLUND TRANSFORMATIONS IN ALIGNED MAGNETOGASDYNAMICS. Rogers, Colin (Univ. of Nottingham, Eng.). Acta Phys. Austr.; 31: No. 1, 80-8 (1970).

Previously, a hodograph system was derived for certain steady, two-dimensional, nondissipative magnetogasdynamic flows in which the velocity and magnetic field are everywhere aligned. Here, general Baecklund transformations are applied, and the hodograph equations are thereby reduced to consideration of the Cauchy–Riemann equations in elliptic regions and to the wave equation in hyperbolic regimes. The specialization of the matrices, which yields magnetogasdynamic reciprocal and adjoint relations, is presented. Further, a new approximated-state relation is established that reduces to the well-known Karman–Tsieu equation of state of ordinary gas dynamics in the limit $A \to \infty$, where A is the Alfvén number. The method may be utilized to approximate certain super-Alfvénic adiabatic flows of a conducting gas past insulated bodies. (M.H.R.)

38192 EXPERIMENTAL STUDY OF THE ROTATION OF AN ELECTRICALLY CONDUCTING VISCOUS LIQUID IN THE PRESENCE OF A UNIFORM AXIAL MAGNETIC FIELD. Bas, Jacky; Chambarel, Andre; Dorlhac, Francois (College Scientifique Univ., Avignon, France). Compt. Rend., Ser. A; 272: 172-4(11 Jan 1971). (In French).

The radial distribution of the tangential velocities to the rotational flow of an electrically conducting viscous liquid, in the presence of a uniform axial magnetic field, was experimentally determined. Mercury was the electrically conducting viscous liquid, and it was contained between two coaxial cylinders, with a common vertical axis and conducting walls. The rotation of the container about its axis produced the rotational flow. (France)

38193 NONLINEAR MAGNETOHYDRODYNAMIC WAVES. Polovin, R. V. Differential Equations (Engl. Transl); 1: No. 4, 382-99(Apr 1965).

Translated from Differentsialnye Uravneniya; 1: No. 4, 499-522(1965).

Shock and simple wave solutions of quasi-linear hyperbolic equations are reviewed with special reference to magnetohydrodynamic equations. An extensive reference list of work by Russians is given. (App. Mech. Rev.)

38194 HYDROMAGNETIC FLOW IN A ROTATING CHANNEL. Nanda, R. S.; Mohanty, H. K. (Indian Inst. of Tech., Kharagpur). Appl. Sci. Res. (The Hague); 24: No. 1, 65-78(Apr 1971).

The steady flow in a parallel-plate channel rotating with an angular velocity Ω and subjected to a constant transverse magnetic field is analyzed. An exact solution of the governing equations is obtained. The solution in the dimensionless form contains two parameters: the Hartmann number, M^2, and K^2, which is the reciprocal of the Ekman number. The effects of these parameters on the velocity and magnetic field distributions are studied. For large values of the parameters, there arose thin boundary layers on the walls of the channel. (auth)

38195 ACCELERATION COVARIANCE IN ISOTROPIC HYDROMAGNETIC TURBULENCE. Mishra, R. S.; Kishore, N.

XUM

(Banaras Hindu Univ., India). Appl. Sci. Res. (The Hague); 24: No. 1, 44-52(Apr 1971).

The turbulent flow of an incompressible, viscous, and conducting fluid that is isotropic and spatially homogeneous is dealt with. The expression for acceleration covariance is derived. The result obtained shows that the defining scalars $\alpha(r,t)$ and $\beta(r,t)$ of the acceleration covariance in MHD turbulence depend on the defining scalars of Q_{ij}, H_{ij}, Π_{ij} and $S_{ik,j}$. (auth)

38196 BOUNDARY-LAYER DEVELOPMENT IN AN MHD DUCT. Merck, W. F. H. (Eindhoven Univ. of Tech., Netherlands). Appl. Sci. Res. (The Hague); 24: No. 1, 21-43(Apr 1971).

A method of calculation for two-dimensional, steady-state, laminar flow in the entrance region of an MHD duct is presented. The electrically conducting fluid in the free stream is compressible, whereas the medium in the boundary layer itself is taken to be incompressible. Thus, the density is variable in the axial direction of the duct only, and the momentum and energy equations for the boundary layer are uncoupled. These equations are solved using an extended Von Kármán–Pohlhausen method as described by U. P. Hwang for a compressible MHD flow with zero electric field. In this study, however, the electric field is essentially not zero, and the MHD duct can work as a generator. The equations of the insulator boundary layer are solved on the assumption that the displacement thickness of the electrode boundary layer equals that of the insulator boundary layer, so the total influence of the varying effective cross section on the free stream is taken into account. In this way a quick method of calculating the MHD flow in the entrance region of a duct is obtained. (auth)

38197 STUDY OF VISCOUS HYPERSONIC MAGNETOAERODYNAMIC BLUNT-BODY PROBLEM. Yoo, Chong-yul. Chicago; Illinois Inst. of Tech. (1970). 129p. University Microfilms Order No. 71-6041.

Thesis.

A numerical method is developed in order to treat the viscous, hypersonic, MHD blunt-body problem. The body and onboard, magnetic dipole source are at zero angle-of-attack. The numerical method treats the shock structure as part of the solution. The unsteady equations and an initial-value problem are developed in order to obtain the steady-state solution. Variable properties are included. Emphasis is placed on the calculation of aerodynamic coefficients, shock alteration, pressure distribution, and adiabatic wall temperature. Comparisons with theory and experiment for both the MHD and non-MHD flows are presented and show good agreement considering the course mesh used. (Diss. Abstr. Int., B)

38198 GEOMETRY OF FIELD LINES IN HYDROMAGNETIC FLUID FLOWS. Rao, P. Sambasiva; Rao, K. Keshav; Purushotham, G. (Osmania Univ., Hyderabad, India. Nagarjunasagar Engineering Coll., Hyderabad, India). Tensor; 22: No. 2, 141-7(May 1971).

The geometric conditions existing between triply orthogonal spatial curves of congruences are enumerated, and the necessary equations to be satisfied by flow quantities in anholonomic coordinates are derived that are used to study some of the kinematic properties of hydromagnetic fluid flows. Considering triply orthogonal spatial curves of congruences, the magnetic lines of force and their principal normals and binormals are related respectively. The velocity vector field defined in this frame of reference and the basic equations governing the fluid flows described are effected into intrinsic form. Introducing the energy density, variation of the Bernoulli surface along the field lines triad is studied. The effect of a force-free magnetic field in hydromagnetic flow is considered, and the necessary conditions governing the force-free field are obtained. Considering the magnetic field to be complex-lamellar, it is observed that the current density lines can be geodesics or asymptotic lines on Beltrami surfaces, which form developables. (M.H.R.)

38199 GEOMETRY OF LINES OF FORCE IN PSEUDOSTATIONARY HYDROMAGNETIC FLUID FLOWS. Murthy, D. N. (Nagarjunasagar Engineering Coll., Hyderabad, India). Tensor; 22: No. 2, 217-22(May 1971).

In a streakline flow, considering triply orthogonal spatial curves of congruences formed by magnetic lines of force, their principal normals and binormals, the kinetic and kinematic properties of perfectly conducting ideal compressible fluids, devoid of viscosity and thermal conductivity, are investigated. The relations of various flow quantities to the geometrical parameters of the lines of force are studied. (M.H.R.)

38200 VORTEX LINES BEHIND A MAGNETOGASDYNAMIC SHOCK WAVE. Mishra, R. S.; Babu, Ram (Banaras Hindu Univ., India). Tensor; 22: No. 2, 243-8(May 1971).

The transformation of coordinates developed by Pant and Mishra [Appl. Sci. Res., Series B, 11: 181-204(1965)] are used to determine the higher-order derivatives of the flow and field parameters. The expression for the curvature and torsion of vortex lines generated behind a magnetogasdynamic shock wave in stationary flows are obtained explicitly. (M.H.R.)

38201 GENERATION OF CURRENTS BY A SHOCK IN A PSEUDOSTATIONARY FLOW OF CONDUCTING FLUIDS. Ram, Rishi; Sharma, V. D. (Banaras Hindu Univ., India). Tensor; 22: No. 1, 1-5(Jan 1971).

It is assumed that the flow on the upstream side of the shock is uniform. The propagation of the shock surface is defined normal to itself, and the magnetic field is oblique to the direction of propagation. (M.H.R.)

38202 UNSTEADY LAMINAR FLOW OF A VISCO-ELASTIC FLUID BETWEEN TWO FLAT PLATES UNDER A TRANSVERSE MAGNETIC FIELD. Agrawal, J. C.; Madan, V. P. (California State Coll., Pa. Univ. of Alberta, Edmonton). Tensor; 22: No. 1, 6-10(Jan 1971).

The flow of a conducting visco-elastic fluid between two parallel nonconducting plates under a transverse magnetic field is studied when there is an exponentially decaying pressure gradient in the direction of flow. Rivlins approach [J. Rat. Mech. Anal., 4: 681-702(1955)] to this class of fluids is followed. (M.H.R.)

38203 STEADY LAMINAR FLOW OF A VISCO-ELASTIC FLUID IN AN ANNULUS IN THE PRESENCE OF A RADIAL MAGNETIC FIELD. Agrawal, J. C.; Madan, V. P. (California State Coll., Pa. Univ. of Alberta, Edmonton). Tensor; 22: No. 1, 11-14(Jan 1971).

The steady laminar flow of a non-Newtonian visco-elastic conducting, incompressible fluid in the space between two coaxial infinitely long circular cylinders is discussed when a radial magnetic field $H_0 = w/r(w = \text{constant})$ emanates from the axis and a constant pressure gradient in the axial direction exists. Neglecting displacement currents and free charges and assuming the Lorentz force as the only body force in the field, the equations for the hydromagnetic flow of the said fluid with constant electric and magnetic properties are given. Solutions of the equations and the limiting cases are presented. (M.H.R.)

38204 CURVATURE OF PSEUDOSTREAM LINES BEHIND A HYDROMAGNETIC SHOCK. Babu, Ram; Mishra, R. S. (Banaras Hindu Univ., India). Tensor; 22: No. 1, 19-23(Jan 1971).

The curvature of a pseudostream line behind a shock wave in the presence of a magnetic field is determined. The differential equations governing the two-dimensional flow of an ideal conducting gas are give. It is assumed that the flow is time-dependent, such that the hydrodynamical and kinematical variables depend only on two parameters x/t and y/t, instead of three variables x, y, and t. (M.H.R.)

38205 STEADY FLOW OF A VISCO-ELASTIC CONDUCTING FLUID BETWEEN TWO POROUS PARALLEL FLAT PLATES IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Agrawal, J. C.; Madan, V. P. (California State Coll., Pa. Univ. of Alberta, Edmonton). Tensor; 22: No. 1, 29-33(Jan 1971).

The problem of steady laminar flow of a conducting visco-elastic fluid between two porous parallel flat plates in the presence of a uniform transverse magnetic field is studied. Following the Rivlin and Ericksen approach [J. Rat. Mech. Anal., 4: 323-425(1955)] to this class of fluids, the general stress–strain relation is written. Neglecting displacement currents and free charges, the governing equations of hydromagnetic flow are presented and solved for an incompressible visco-elastic fluid with constant electric and magnetic properties using rationalized mks units (when Lorentz force is the only body force). (M.H.R.)

38206 VORTICITY JUMP ACROSS A PSEUDOSTATIONARY GASDYNAMIC DISCONTINUITY. Rm, Rishi; Sharma, V. D. (Banaras Hindu Univ., India). Tensor; 22: No. 1, 91-2(Jan 1971).

An attempt is made to provide a simple vectorial derivation from the momentum equation alone for the vorticity jump across a gasdynamic discontinuity in a pseudostationary flow of inviscid and thermally conducting fluids. The result obtained is not limited to shock waves but would also hold for a condensation or detonation wave. (M.H.R.)

38207 TWO-DIMENSIONAL MHD STABILITY OF AN ELASTICO-VISCOUS FLUID. Sriramulu, A. N.; Malhotra, R. C. (Indian Inst. of Tech., Delhi). Tensor; 22: No. 1, 98-102(Jan 1971).

The two-dimensional stability of an elastico-viscous fluid in the presence of a coplanar magnetic field is examined. The critical

Reynolds number increases or decreases depending upon the magnitude of the non-Newtonian parameter and the intensity of the magnetic field. The governing equations are presented, and the stability problem is considered. (M.H.R.)

38208 UNSTEADY LIQUID METAL FLOW IN A CONDUCTING MHD GENERATOR CHANNEL WITH ARBITRARY CHANGE IN FLOW RATE. Ryabinin, A. G.; Khozhainov, A. I. High Temp. (USSR) (Engl. Transl.); 8: No. 5, 938-41(Sep-Oct 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 5, 1002-6(Sep-Oct 1970).

A solution is presented for the problem of laminar, unsteady, liquid-metal flow in a flat, conducting MHD generator channel with provision for instantaneous change in applied magnetic field and arbitrary time dependence of flow rate. An example is considered for which the liquid-metal flow rate in the generator channel changes exponentially with time. Computed data are presented for the time dependence of power losses due to viscous friction and to the longitudinal pressure gradient which include magnetic field and liquid-metal acceleration effects. (auth)

38209 APPROXIMATE SOLUTION OF THE FLOW PROBLEM OF A PLASMA WITH VARIABLE PHYSICAL PROPERTIES OVER THE INSULATING WALLS OF AN MHD CHANNEL. Iotkovskii, B. G.; Kirillov, V. V. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 5, 942-6(Sep-Oct 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 5, 1007-12(Sep-Oct 1970).

Consideration is given to the laminar flow of a conducting, compressible medium with variable physical properties along the insulating walls of an MHD generator channel. Change in external flow velocity and in the magnetic field induction along the channel can be arbitrary. A modified Kármán–Polhausen method is proposed for boundary-layer computations, and an estimate of the accuracy of the proposed method is presented. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 37762, 38094, 38174, 38175, and 38925.

38210 SYMPOSIUM ON ELECTROMAGNETIC PROBING OF THE UPPER ATMOSPHERE, CALCUTTA, JULY 1969. Indian J. Pure Appl. Phys.; 8: 507-84(Sep 1970). (CONF-690729).

An individual abstract was prepared for each of the 19 papers included here. (J.C.W.)

For abstracts of individual papers see: 38174 and 38211–38228.

38211 ELECTROMAGNETIC PROBING OF THE ATMOSPHERE: THE MESOSPHERE AND THE LOWER THERMOSPHERE. Mitra, A. P. (National Physical Lab., New Delhi). Indian J. Pure Appl. Phys., 8: 507-15(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

The techniques available for the study of the parameters of the neutral and ionized particles of the mesosphere and the lower thermosphere are outlined and compared. Both ground-based and space techniques are included. The effectiveness of these techniques in the determination of the distribution of electron and ion densities, collision frequency, electron temperature, and the ionospheric loss rates is discussed. (auth)

38212 ELECTROMAGNETIC PROBING OF THE ATMOSPHERE: THE UPPER IONOSPHERE. Reddy, B. M.; Lakshmi, D. D. R. (National Physical Lab., New Delhi). Indian J. Pure Appl. Phys.; 8: 516-22(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

A critical review of the different methods best suited for exploring the topside ionosphere, the F region and partly the E region is made. An outline of the basic theory of each experiment is given and its limitations are discussed. Some of the major contributions of these techniques and their scientific relevances are pointed out. Intercomparison between the various techniques is presented using some of the most recent observational data. Most of these techniques fall in the collision-dominated lower regions of the ionosphere. (auth)

38213 IONOSPHERIC ABSORPTION MEASUREMENTS AT 1.55 MHz BY THE URSI A_3 METHOD. Sarma, M. Satyanarayana; M.; Gopal Rao, M. S. V.; Anjaneyulu, C. (Defence Electronics Research Lab., Hyderabad, India). Indian J. Pure Appl. Phys.; 8: 523-5(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

Ionospheric absorption measurements were made by using C–W transmissions from Madras (lat., 13°05′N; long., 80°17′E; and geomag. lat., 3°05′N) received at oblique incidence at Hyderabad (lat., 17°21′N; long., 78°28′E; and geomag. lat., 07°39′N) at a frequency of 1.55 MHz over a period of about two years. The diurnal, seasonal, and solar-cycle variations were studied. The exponent of cos χ (where χ is the solar–zenith angle) in the diurnal variation is found to be 0.9 on the average. The subsolar absorption (L') is found to increase with the sun-spot number $\bar{R}$ according to the relation $L' = 31.0\ (1 + 0.0096\ \bar{R})$ for the values of $\bar{R}$ ranging from 50 to 100. The noontime ionospheric absorption corrected for the solar-cycle effect showed a systematic seasonal variation with a cos χ exponent of 0.8 except for the period April to August when the absorption was found to be abnormally low. The subsolar absorption L' exhibited a clear seasonal variation with a broad maximum during winter months and a minimum during summer months. This feature, together with the abnormal decrease in absorption during the summer months, is attributed to the enhanced occurrence of sporadic-E ionization during the summer months. (auth)

38214 STUDY OF LOWER IONOSPHERIC ABSORPTION OF COSMIC RADIO NOISE POWER ON 28.6 MHz AT WALTAIR. Ahmed, Md. Iqhbal; Rao, B. Ramachandra (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys.; 8: 526-8(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

Results of 28.6-MHz cosmic-noise absorption measurements carried out during August 1965–July 1966 at Waltair (17°43′N, 83°18′E) are presented. It is found that the contribution of the lower ionosphere is maximum around noon, but generally less than 50% of the total absorption. The E-region contribution calculated according to Jaeger's expression is very small at the operating frequency of 28.6 MHz. The values of the cos χ exponent n for the diurnal variation of D-region absorption are found to be 1.14, 1.05, and 0.99, respectively, for summer, equinoxes, and winter. The average value of relaxation time is found to be 25 min. The cos χ exponent for the seasonal variation of D-region absorption is found to be 1.94 and is in good agreement with the results of earlier investigators. (auth)

38215 INTERRELATIONS BETWEEN GEOMAGNETIC AND IONOSPHERIC LUNAR TIDES AT EQUATOR. Sharma, R. P.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Indian J. Pure Appl. Phys.; 8: 533-6(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India jul 1969). See CONF-690729.

The lunar semimonthly oscillations in the solar daily range of H and in midday values of f_0F_2 at equatorial stations are shown to vary sympathetically to each other as regards latitudinal, seasonal, and solar daily variations. Lunar daily variations at fixed lunar ages in H, $N_{max}F_2$, $h_{max}F_2$, Y_mF_2 and N_t at Huancayo indicate a definite effect of magnetic-field variations on the equatorial ionosphere. Analyses of lunar tides at fixed heights of the ionosphere show that the amplitudes of oscillations increase systematically with height, and the effects are maximum during the evening hours. (auth)

38216 EFFECT OF MAGNETIC ACTIVITY ON THE DRIFT AND ANISOTROPY OF IONOSPHERIC IRREGULARITIES. Jogulu, C.; Rao, B. Ramachandra (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phy.; 8: 537-40(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

The results showing the effect of the magnetic activity on the parameters drift and anisotropy of the irregularities in the E and F regions of the ionosphere, as observed from a study of the diurnal variation of these parameters under quiet and disturbed conditions, are presented. The true drift velocity (V) and the random velocity (V_c) show marked enhancement during the disturbed conditions compared to the quiet-day conditions in the case of the E region, while a decrease of drift is noticed in the case of the F region during the disturbed conditions. An increase in the axial ratio (r) as well as in the size of the irregularity (a) is observed during disturbed conditions in the E region, but no appreciable changes are found in the case of the F region. Further, the diurnal-variation curves for the quiet and disturbed conditions for the parameters V_c and a are found to be strikingly similar for both the E and F regions, adding significance to the diurnal variation of these parameters. (auth)

38217 LUNAR OSCILLATIONS IN THE IONOSPHERIC ABSORPTION. Chakravarty, S. C.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Indian J. Pure Appl. Phys.; 8: 541-3(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

The results of studies on lunar oscillations in the ionospheric absorption measurements (A1 method) at Colombo for the periods 1957–59 and 1964–68 and at Singapore for the period 1951–55 are described. An alternative parameter for ionospheric absorption, f-min, has been used at Huancayo, Chimbote, Talara, and Panama for the study of lunar variations in the lower ionosphere in more detail. The phase reversal of the lunar semi-monthly tides in the D region between equatorial and high latitudes takes place at a slightly lower latitude compared to the F-region tides. There are large seasonal variations of the phase of the tides, being more prominent during the high sunspot years. The lunar tides in f-min compare quite well with those in absorption. The absence of the enhancement of the amplitude of the lunar tides close to the magnetic equator shows that they are unaffected by the equatorial-electrojet currents. (auth)

38218 IONOSPHERIC INDICATION OF SHORT-TIME SOLAR ACTIVITY VARIATIONS. Bhattacharyya, J. C.; Sunder, R. S. (Kodaikanal Observatory, India). Indian J. Pure Appl. Phys.; 8: 544-5(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

A series of Lyot filtergrams were photometrically analyzed and the variations in the plage intensity determined on a number of days. From simultaneous ionosonde records, correlation was sought between the electron density variation at fixed heights and that of the H-alpha plage index. The results indicate positive correlation at lower heights, gradually falling off with height in the ionosphere. (auth)

38219 ENHANCEMENT OF fE_s AND E_s-MULTIPLES WITH THE INCIDENCE OF THUNDER SQUALLS. Datta, R. N. (Univ., of Calcutta). Indian J. Pure Appl. Phys.; 8: 546-7(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

Enhancement of fE_s and E_s multiples with occurrence of severe thunderstorms of the squall type was studied. Results indicate the existence of a definite relationship between the onset of thunder squall and the ionization in the sporadic-E region. The number distribution of E_s multiples during a thunder squall further hints at the possible enhancement of a lower ionospheric ionization. (auth)

38220 IONOSPHERIC IRREGULARITIES AND THEIR DRIFTS AT THUMBA DURING 1964–68. Chandra, Harish; Misra, R. K.; Deshpande, M. R.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Indian J. Pure Appl. Phys.; 8: 548-50(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

Results of the analyses of fading of radio waves reflected from the E and F regions of the ionosphere over Thumba as received on three spaced aerials during the period 1964–68 are discussed. During any portion of solar cycle, the drift is predominantly towards west during the daytime and towards east during the nighttime, the change-over occurring around 0700 and 2000 hrs. The annual average drift speeds (apparent) during the years 1964–65 and 1967–68 are, respectively, 134 and 108 m/sec for the E region and 170 and 146 m/sec for the F region. The drift speeds are maximum during the equinoxes for both the regions throughout the solar cycle. The full correlation analyses of the fading records show that the diffraction patterns at Thumba are highly anisotropic, suggesting that the ionospheric irregularities are elongated along the magnetic lines of force. The axial ratios of the patterns during low- and high-sunspot years are 3 and ≈12 respectively. (auth)

38221 F-REGION DISTURBANCES IN THE AUSTRALASIAN ZONE DURING IGY–IGC. Rajaram, Girija; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Indian J. Pure Appl. Phys.; 8: 551-4(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

A study of f_0F_2 in the east zone (i.e. Australasian zone) during magnetically disturbed conditions shows the existence of some asymmetry between the northern and southern hemispheres. During the daytime hours of the winter months, there is a prominent increase in $D/Q(f_0F_2)$, the ratio of disturbed to quiet values of f_0F_2, between 40°N and 70°N dip. Similar but rather a flatter hump is observed in the southern hemisphere in the daytime in the local winter months. These humps seem to get stronger during the night hours of the local winter months. The $D_{\pi}(f_0F_2)$ variations show an unexpected positive phase at the Japanese stations together with the region of reduced disturbed f_0F_2 values around 30° dip. The effect of storms on f_0F_2 seems more enhanced in the northern hemisphere than in the southern hemisphere. Within ±40° dip the disturbance effects in f_0F_2 are associated with the normal solar daily variation of f_0F_2, which in turn is controlled by the equatorial electrojet current. (auth)

38222 CHARACTERISTICS OF LARGE-SCALE IONOSPHERIC IRREGULARITIES. Tyagi, Tuhi Ram. (National Physical Lab., New Delhi); Somayajulu, Y. V.; Prakash, Sant; Lal, J. B. Indian J. Pure Appl. Phys.; 8: 555-9(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

The Faraday fadings of 40-MHz transmissions from the satellite Explorer-22 were recorded at two stations, Delhi and Kurukshetra, 160 km apart along a N–S baseline from June 1968 to April 1969, with a view to studying the large-scale irregularities of the ionosphere. The height of these irregularities was derived from the time difference between similar fluctuations in the fading period at the two stations. Out of the nearly 200 simultaneous records suitable for analysis, only 10 records showed similar fluctuations at both stations, yielding a total of 25 irregularities. The height of these irregularities varied from 230 to 710 km, the most common height being 350 km. About 28 records, which have shown fluctuations in Faraday fadings either at Delhi or Kurukshetra, were analyzed and about 70 irregularities observed. The electron contents of the irregularities varied from 4×10^{14} to 1.2×10^{16} electron/m^2. The horizontal sizes were found to range from 10 to 250 km. The content of the irregularities was independent of their size. The size as well as content of the irregularities showed no correlation with latitude or Earth's magnetic field. The orientation of the irregularities was determined from the two-station study. It was found that the large-scale irregularities are not field-aligned, in contrast to the the small-scale irregularities that were found to be elongated along the field lines. (auth)

38223 STUDY OF IRREGULARITIES IN THE F REGION OF THE IONOSPHERE. Srivastava, S. K.; Tantry, B. A. P. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 8: 560-3(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

The simultaneous records of amplitude focusing and phase-path changes of vertically reflected echoes at three spaced receivers were used to determine the slide velocity of the point of reflection over the curved surface of the traveling ionospheric disturbances (t.i.d.). This slide velocity is then added vectorially to the apparent fluctuating horizontal–drift velocities of the small-scale irregularities obtained from the usual Mitra's technique. The resultant horizontal-drift velocities of the irregularities are found to be constant with time. It is thus concluded that the slide of point of reflection over the curved surfaces of t.i.d. causes the rapid fluctuations in the apparent drift velocities of small-scale irregularities. From more than one hundred observations of large-scale irregularities during August 1968–May 1969, some characteristics of the large-scale irregularities were also investigated. (auth)

38224 VERY LOW FREQUENCY (VLF) EMISSIONS AT LOW LATITUDES. Lalmani; Somayajulu, V. V.; Tantry, B. A. P. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 8: 564-8(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

The results of calculations of the particle energies required under either the longitudinal or the transverse-resonance condition to generate vlf hiss at various low geomagnetic latitudes are presented. It is found that the minimum energy required by electrons to generate vlf hiss under the longitudinal resonance conditions is of the order of 10 eV at geomagnetic latitudes of 13 to 15°. However, the calculated total power radiated by Cherenkov processes due to the intense fluxes of soft electrons observed at 300-km ionospheric heights is three orders of magnitude below the power observed by satellites at ionospheric heights. The possible amplification of vlf waves by the plasma-instability mechanism is investigated as an alternative to the mechanism of the occurrence of vlf emissions. (auth)

38225 FLARE EFFECTS ON 1f RADIO WAVES PROPAGATED OVER A DISTANCE OF ABOUT 1600 KM. Ramanamurty, Y. V. (National Physical Lab., New Delhi). Indian J. Pure Appl. Phys.; 8: 569-72(Sep 1970). POSI

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

The peculiar advantages for flare patrol in recording the field intensity of radio waves in the range 100 to 200 kHz at distances in the range 1000 to 1500 km are pointed out. The suitability of this method for the study of ionospheric effects due to celestial x rays is discussed. For illustration, the characteristics of 164-

kHz radio waves propagated over a distance of about 1600 km are discussed in relation to flare effects. Study of the effect of the Sco XR-1 flare on the field intensity of 164-kHz radio waves is emphasized. (auth)

38226 PROPAGATION OF VLF ELECTROMAGNETIC WAVES THROUGH THE MAGNETOSPHERE. Singh, R. P.; Singh, R. N. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 8: 573-6(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

Various propagation characteristics of very low frequency (vlf) waves in the magnetosphere are studied. Expressions for group refractive index and group velocity of vlf waves are derived. From these parameters an expression for propagation time of vlf waves is derived. The propagation time for ducted magnetospheric whistlers is calculated for different L-values, and these are found to lie within the limits of experimental measurements. Causes for the variation of propagation time under disturbed magnetospheric conditions are discussed. (auth)

38227 ELECTRON CONTENT MEASUREMENTS FROM FARADAY FADING OF SATELLITE TRANSMISSIONS DURING LOW AND HIGH SOLAR ACTIVITY. Tyagi, Tuhi Ram; Somayajulu, Y. V. (National Physical Lab., New Delhi). Indian J. Pure Appl. Phys.; 8: 577-80(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

Ionospheric electron contents were measured at Delhi (28.6°N, 77.2°E) utilizing the Faraday fading of Explorer-22 transmissions for the period October 1964–February 1969. The average maximum values of electron content for low solar-activity period during winter and summer are 1.45×10^{17} m^{-2} and 0.25×10^{17} m^{-2}, respectively. The corresponding values for high solar-activity period are 4.85×10^{17} m^{-2}, 4.35×10^{17} m^{-2}, 0.48×10^{17} m^{-2} and 0.75×10^{17} m^{-2}, respectively. No seasonal anomaly exists during a low-solar-activity period, in contrast to its presence during a high-solar-activity period during daytime. The electron-content values are found to be independent of magnetic activity (ΣK_p) both during low and high solar activity. During low solar activity the electron content is also independent of solar flux (10.7 cm) until the flux reaches about 100 units; a positive correlation is found for further increase in solar activity. (auth)

38228 TOTAL ELECTRON CONTENT OF IONOSPHERE AT KURUKSHETRA. Lal, J. B.; Prakash, Sant (Kurukshetra Univ., India). Indian J. Pure Appl. Phys.; 8: 581-4(Sep 1970).

From Symposium on electromagnetic probing of the upper atmosphere; Calcutta, India (Jul 1969). See CONF-690729.

Faraday fadings of 40-MHz radio transmissions from the satellite Explorer-22 recorded at Kurukshetra (geogr. lat., 29.9°N; long., 76.8°E; dip, 45.6°) during the period June–December 1968 were used to calculate the overhead ionospheric electron content. The electron content values were corrected for horizontal gradients of ionization. The average maximum electron-content values during high solar activity for summer and winter are 4.1×10^{17} and 5.4×10^{17} electrons/m^2, respectively. The corresponding minimum values are 0.8×10^{17} and 0.2×10^{17} electrons/m^2, respectively. The values of the ratios of maximum-to-minimum electron content during summer and winter are about 5 and 27, respectively. There seems to be a slight positive correlation with 10.7-cm solar flux, but no correlation was obtained with the magnetic activity (ΣK_p). (auth)

38229 FIELD-ALIGNED CURRENT INSTABILITIES IN THE HIGH-LATITUDE IONOSPHERE. Kindel, Joseph Martin. Los Angeles; Univ. of California (1970). 190p. University Microfilms Order No. 71-4872.

Thesis.

Conditions under which field-aligned electron currents can cause plasma microinstabilities and the macroscopic implications of the resulting turbulence were determined for the high-latitude ionosphere. Ionospheric parameters focus on the current instabilities of the electrostatic ion-cyclotron wave and ion-acoustic wave. Original work of Drummond and Rosenbluth on the ion-cyclotron wave was extended to arbitrary electron-to-ion temperature ratio and to higher harmonics of the cyclotron frequency; throughout comparisons were made with the ion-acoustic instability and an electron-to-ion temperature ratio range over which ion-cyclotron waves and not ion-acoustic waves are excited were found. Furthermore, current instabilities in multi-ion plasmas were examined, and again ion-cyclotron waves were found to be the most unstable waves over an even larger (T_e/T_i) range. Application of the instability analysis to particular ionospheric models shows that ion-cyclotron waves are expected to go unstable in the far topside at smaller currents than is required for ion-acoustic destabilization. Using arguments of strong turbulence, it was found that ion-cyclotron waves once excited, grow to a sufficient amplitude to provide an anomalous resistance for heating of the far topside. Ionospheric heating rates and resulting dc electric fields are estimated. (Diss. Abstr. Int., B)

38230 SIGNIFICANCE OF SPECIAL FEATURES OF THE ORBIT OF THE AZUR SATELLITE FOR THE STUDY OF SUBSTORM PHENOMENA. Rossberg, L.; Theile, B. (Max-Planck Inst. fuer Aeronomie, Lindau, Ger.). ELDO/ESRO Sci. Tech. Rev.; 3: No. 1, 3-16(1971).

The German research satellite AZUR is essentially a low-altitude, polar-orbiting satellite. The orbit characteristics distinguishing it from other polar satellites are outlined and their effects on the observation of auroral-zone phenomena are discussed. Typical measurements of an electron flux with an energy greater than 40 keV are presented as examples. (France)

38231 RADIAL DIFFUSION OF TRAPPED PARTICLES AND SOME OF ITS CONSEQUENCES. Walt, Martin (Lockheed Palo Alto Research Lab., Calif.). Rev. Geophys. Space Phys.; 9: 11-25(Feb 1971).

The nonadiabatic motion of geomagnetically trapped particles across L shells has been inferred from the measured distributions of trapped particles and has also been observed directly in a number of cases. This type of motion has important influences on both the steady-state structure and the dynamics of the radiation belts. The characteristics of the radial motion were evaluated and are generally consistent (within an order of magnitude) with the radial diffusion expected from fluctuations in the magnetospheric electric and/or magnetic fields. However, the complexity and variability of the observed phenomena suggest that several basic processes are acting simultaneously, and further efforts are needed to identify specific mechanisms. (auth)

38232 EXTRATERRESTRIAL LYMAN ALPHA. Tinsley, B. A. (Univ. of Texas, Dallas). Rev. Geophys. Space Phys.; 9: 89-102(Feb 1971).

Theoretical work and observations on extraterrestrial Lyman α are reviewed. A source of extraterrestrial Lyman α near the solar apex is, probably, scattering of solar Lyman α on cold interplanetary hydrogen that has penetrated to the inner solar system. A minor source of interplanetary hydrogen comes from the breakup of comets. Galactic sources of Lyman α are probably also present, and such emission would tend to be rendered isotropic, depending on the amount of interstellar hydrogen in the near vicinity of the solar system. (auth)

38233 TRAPPED SOLAR WIND HELIUM AND NEON IN SURVEYOR 3 MATERIAL. Buehler, F.; Eberhardt, P.; Geiss, J.; Schwarzmueller, J. (Univ., Bern). Earth Planet. Sci. Lett.; 10: 297-306(Feb 1971).

The Apollo 12 astronauts salvaged an unpainted Al tube from the Surveyor-3 spacecraft. He and Ne were measured in sectors cut from a small ring from this tube. The lower side of the tube is contaminated by lunar dust, which cannot be completely removed by ultrasonic cleaning. The upper half shows very little or no dust contamination and contains trapped solar wind He and Ne with $^4He/^{20}Ne = 295$ in the trapped gas. This value is lower than the ratios measured by the Apollo 11 and 12 SWC experiments. This could be due to ^4He diffusion loss or to a small residual dust contamination. The ^4He distribution around the Al-tube is in agreement with the theoretically expected distribution and corresponds to an average solar wind ^4He flux of 7×10^6 cm^{-2} sec^{-1}. If ^4He diffusion loss had occurred the average ^4He flux could be as high 13×10^6 cm^{-2} sec^{-1}. Neglecting the small influences of a possible dust contamination or of diffusion loss we obtain the following average isotopic compositions for the solar wind during the exposure of the Surveyor-3 material: $^4He/^3He = 2700 \pm 130$; $^{20}Ne/^{22}Ne = 13.3 \pm 0.4$ and $^{22}Ne/^{21}Ne = 31 \pm 5$. Compared with the Apollo 11 and 12 SWC results, the $^4He/^3He$ ratio is unexpectedly high. (auth)

38234 SCHUMANN RESONANCES AND WORLDWIDE THUNDERSTORM ACTIVITY. DIURNAL VARIATIONS OF THE RESONANT POWER OF NATURAL NOISES IN THE EARTH-IONOSPHERE CAVITY. Ogawa, Toshio; Tanaka, Yoshikazu; Yasuhara, Michihiro (Kyoto Univ.). J. Geomagnet. Geoelec.; 21: No. 1, 447-52(1969).

Electric vertical and horizontal NS and EW components of natural elf electromagnetic noises were observed from Feb. 1967 through June 1968. Mean diurnal variations of the Schumann resonance power were obtained for the first three modes from noise spectra. The variations show completely different patterns for each component, and change considerably month by month. The diurnal amplitude also varies by 1 to 7 db from the mean daily

values. The results are compared with the diurnal variations derived from the simple theory considering worldwide thunderstorm activity as noise sources. There are fairly good agreements between the experimental and theoretical results, especially for EW component. For vertical and NS components, thunderstorm effects from Africa seem relatively smaller than expected. The time of this effect is in local night. This shows that local night conditions of the lower ionosphere, as the upper boundary of the Earth–ionosphere cavity, make the received intensity of vertical and NS components decrease. (auth)

38235 AREA AVERAGING OF ATMOSPHERIC ELECTRIC CURRENTS. Ruhnke, Lothar H. (Atmospheric Physics and Chemistry Lab., Boulder, Colo.). J. Geomagnet. Geoelec.; 21: No. 1, 453-62(1969).

The global atmospheric electric-current flow may be determined, if local influences can be eliminated, by measuring the total Maxwell current flowing to the surface of all fair-weather areas. A new method to reduce the effect of locally produced disturbances on surface measurements of the atmospheric electric-current density is described. Experiments indicate that, from a few seconds to a few hours, the standard deviation of the total current density decreases approximately with the square root of the sensor size. Locally generated currents may, therefore, be effectively suppressed by area averaging. (auth)

38236 CONSIDERATION ON THE TIDAL WAVE TRANSMISSION THROUGH THE IONIZED ATMOSPHERE. Kato, Susumu; Matsushita, Sadami (High Altitude Observatory, Boulder, Colo.). J. Geomagnet. Geoelec.; 21: No. 2, 471-8(1969).

The effect of $(J \times B_0)$ force on the tidal-wave transmission, where J is electric current and B_0 the geomagnetic field, was investigated. It was found that the force is considerably effective on any positive mode of the diurnal tide and the semidiurnal tide except for the first semidiurnal mode. The diurnal and semidiurnal velocity oscillations of these modes, which are excited in the lower neutral atmosphere, cannot be transferred to the ionized atmosphere. An exception occurs, however, at the magnetic equator, where $(J \times B_0)$ force is almost ineffective. The refractive index of the tidal wave is calculated for a simple model where the Coriolis force is ignored and $(J \times B_0)$ is assumed to be uniform with longitude and latitude. (auth)

38237 EXCITATION OF EXTREMELY LOW FREQUENCY SFERICS. Hill, R. D. (General Research Corp., Santa Barbara, Calif.). J. Geomagnet. Geoelec.; 21: No. 2, 479-86(1969).

There are difficulties in accepting the theory that elf sferics are mainly excited by cloud-to-ground discharges. Some discrepancies between theory and experiment are discussed. A new approach to the analysis of the frequency content of intracloud and cloud-to-ground discharges is taken by Fourier integrating the whole discharge. It is shown that the current-moment spectrum of the average intracloud discharge is approximately an order of magnitude larger than the average cloud-to ground discharge spectrum in the important elf sferics range from 10 to ~100 Hz. (auth)

38238 COMPARISON OF ARCTIC, ANTARCTIC, AND OCEANIC ATMOSPHERIC ELECTRIC MEASUREMENTS. Schuman, Elmer L. (Atmospheric Physics and Chemistry Lab., Boulder, Colo.). J. Geomagnet. Geoelec.; 21: No. 2, 487-93(1969).

Data on the diurnal variation of the air–Earth current and electric field obtained on the Carnegie ship cruises in 1928–29, at Thule, Greenland in 1958–59, and at the Amundsen–Scott Station at the South Pole in 1964 are compared from a numerical point of view. The normalized results are found not to agree. The analysis of the degree of significance of the disagreements reveals that different methods of normalizing yield drastically different interpretations; expressing the data as a percentage of the yearly mean renders the differences in the results insignificant at the 75% level while, if a daily mean is employed, those differences are found to be significant at the 90% level. The effects of various normalizing procedures on the dispersion of the data are also discussed. (auth)

38239 MID-LATITUDE ELECTRON DENSITY PROFILE AS REVEALED BY ROCKET EXPERIMENTS. Maeda, Ken-ichi (Kyoto Univ.). J. Geomagnet. Geoelec.; 21: No. 2, 557-67(1969).

Data since 1946 on sounding-rocket experiments on electron density profiles for the midlatitude ionosphere are tabulated. Histograms are presented for electron-density measurements in each month of the year and at each hour of the day. Some average daytime profiles for some specific solar activities and some average nighttime profiles are given. Results for normal daytime profiles are satisfactory, while the standard nighttime ionospheric profiles are not established. (J.C.W.)

38240 SHELL SPLITTING MODIFICATION BY SUPERIMPOSED ELECTRIC FIELDS. Catchpoole, J. R. (Univ. of Queensland, Brisbane). J. Geomagnet. Geoelec.; 21: No. 3, 615-22(1969).

Consideration is given to changes in the extent of shell splitting due to the presence of superimposed electric fields. In displacing the spiraling–mirroring domain of trapped particles, such superimposed fields constitute a pitch-angle dispersion process. This produces a corresponding change in particle radial displacement, and so is accompanied by a modification in the overall shell splitting. (auth)

38241 APPARENT RESONANCE FREQUENCIES OF THE EARTH–IONOSPHERE CAVITY WHEN EXCITED BY A SINGLE DIPOLE SOURCE. Jones, D. Llanwyn (Univ. of Colorado, Boulder). J. Geomagnet. Geoelec.; 21: No. 3, 679-84(1969).

The apparent resonance frequencies of the Earth–ionosphere cavity as determined from the location of the maxima of the electric or magnetic field components in the amplitude–frequency plane depend on the source–observer separation. Here, the variations of these apparent resonance frequencies with source range are presented for a realistic propagation constant (or ionospheric) model and for a single dipole source. The data presented have an application to the interpretation of experimentally determined diurnal variations of the apparent resonator-mode frequencies. (auth)

38242 ABNORMAL ENHANCEMENTS OF HF NOISE INTENSITY AT SYOWA STATION, ANTARCTICA. Nishimuta, Ichiro; Ose, Masami; Sinno, Kenji. J. Geomagnet. Geoelec.; 21: No. 3, 697-700(1969).

High-frequency atmospheric noise observations carried out at Syowa Station, Antarctica, during May through Sept., 1967 indicate that abnormal enhancements of noise level correlate with both ionospheric absorptions and geomagnetic disturbances. Frequencies of the observation are within the guard bands of the radio-standard waves 10-, 15-, and 20-MHz and 1-KHz bandwidth. (J.C.W.)

38243 INFLUENCE OF MAGNETOPLASMA ON GYROSYNCHROTRON RADIATION. Ogawa, Tadahiko; Sakurai, Kunitomo (Kyoto Univ.). J. Geomagnet. Geoelec.; 21: No. 4, 705-22(1969).

The influence of a cold and collisionless magnetoplasma on the gyrosynchrotron radiation from an accelerated electron is considered in detail by solving Maxwell's equations with the aid of a Green tensor and a Fourier transformation. Electromagnetic fields at great distance from a point source are discussed. The frequency spectra of the radiation power of both ordinary and extraordinary waves are numerically calculated for various values of ambient plasma parameters and energy of a radiating electron. It is pointed out that the waves radiated at low harmonic numbers of the gyrofrequency of a radiating electron cannot propagate in a plasma and that the influence of a magnetoplasma on the spectra is important under the condition of $f_p \geq f_H$. These are due to dispersion and anisotropy of the medium. Applications of the results to solar radio type-IV bursts are briefly discussed. (auth)

38244 EFFECTS OF A LONGITUDINAL ELECTRIC FIELD ON PARTICLE MOTION IN AN ASYMMETRICAL MAGNETOSPHERE. Catchpoole, J. R. (Univ. of Queensland, Brisbane). J. Geomagnet. Geoelec.; 21: No. 4, 723-9(1969).

A change in the spiraling–mirroring domain of trapped electrons and a consequent change in the precipitation to ionospheric heights result from the superposition of a longitudinal electric field along the direction of the lines of force of the Earth's magnetic field. A previous assessment of the extent of this effect is extended here to consider precipitation from a model for the distorted magnetosphere. The relative precipitation increases from the dayside field, the nightside field, and the symmetric (or dipole) field are compared. (auth)

38245 SEARCH FOR SUPERPOSED EFFECTS IN S_q. Thomas, G. M. (Univ. of Edinburgh). J. Geomagnet. Geoelec.; 21: No. 4, 731-49(1969).

A search for superposed effects in S_q as revealed by data taken from the publications of Lerwick and Eskdalemuir observatories is described. The method uses histograms representing the frequency with which different values of H are recorded, after first removing the secular change. The histograms are used to form their associated characteristic functions (Fourier transforms) which are then factorized by locating their zeroes. When the zeroes are all plotted in a suitable representation, the presence of superposed effects should be manifested by the zeroes forming families of radial lines. The samples of data taken from Lerwick were found to be too small to yield satisfactory results; those

from Eskdalemuir were more successful, although only the data relating to the epoch of maximum solar activity provided quantitative results. It seems that the quiet daily variations in the horizontal component at Eskdalemuir in winter consist of two components. The investigation also provides a value for the zero level of S_q, the value the field would have if the Sq current system, including its purely zonal part, was arrested. Depending on certain assumptions this zero level appears to lie about 12 or 17 nT above the daily mean value of field on International Quiet Days. (auth)

38246 ELECTRICAL NATURE IN PLANETARY UPPER ATMOSPHERE. Obayashi, Tatsuzo (Tokyo Univ.). J. Geomagnet. Geoelec.; 20: No. 4, 291-7(1968).

The present status of the planetary atmospheric electricity is discussed, including ionization and the equilibrium of space charges in the Earth's atmosphere. Large-scale electric fields existing in the atmosphere are divided into three sources of origin: the lower atmosphere, the ionosphere, and the magnetosphere. The lower atmospheric electric-field system is generated primarily by thunderstorm electricities, while the ionospheric and magnetospheric ones are attributed to the motion of plasma in the geomagnetic field. It is revealed that the atmospheric electricity in other planets is of considerable interest because of its variety in their environmental conditions. A brief description is also given on the techniques for space electricity measurements. (auth)

38247 GEOMETRY OF THE MAGNETOSPHERE. II. A WEAKLY CONNECTED MODEL OF THE GEOMAGNETIC TAIL. Wentworth, R. C. (Univ. of California, Berkeley). J. Geomagnet. Geoelec.; 20: No. 4, 299-304(1968).

A model field configuration from two anti-parallel solenoids is discussed to illustrate that the magnetosphere is pressed by the solar wind into three topologically distinct regions, the topologically unconnected upper and lower pole cap-tail flux tubes and the central, connected core. It is concluded that the solar-wind plasma in the neutral sheet is flowing downstream away from the Earth. The suggestion that the plasma in the neutral sheet would blow a distant neutral point away downstream is in accordance with the present analysis. The downstream-flowing plasma is electrically polarized by the perpendicular component of magnetic field northward across the neutral sheet, the resultant space charge giving rise to a dusk-to-dawn electric field across the tail. The cross electric field causes plasma to drift from the region of contact in the neutral sheet up and down into the tail proper, thus being responsible for the observed plasma sheet. (J.C.W.)

38248 EFFECTS OF THE ELECTRON MOTION ALONG MAGNETIC FIELD LINES ON TORSIONAL HYDROMAGNETIC OSCILLATIONS. Tamao, Tsutomu (Tokyo Univ.). J. Geomagnet. Geoelec.; 20: No. 4, 305-13(1968).

By using the drift kinetic approximation, effects of the electron motion along the magnetic-field lines on axisymmetric torsional hydromagnetic oscillations in an inhomogeneous, low-β plasma are considered. The result indicates that eigen oscillations are only possible when there is an energy-trapping region between the turning points. If the simple spatial distribution of the Alfvén speed, V_A, is assumed, which has a trough corresponding with the sudden density decrease near the plasmapause, no effective trapping of oscillations appears near the trough for the case of the cold plasma limit, $V_A \gg V_e$. The existence of the trapping region of oscillation is strongly dependent on the relative magnitude of V_A to the electron thermal velocity, v_e. For the case of $v_e \gg V_A$, the resonance oscillation is possible within the trough. However, the deviation of the resulting eigenfrequency from that corresponding to the field line at the bottom of the trough is small. In general, the condition for the resonance trapping of oscillations near the trough is $v_e \gg V_0$ (the minimum value of V_A) beyond the density knee. (auth)

38249 ROCKET OBSERVATIONS OF VISIBLE AND ULTRAVIOLET DAYGLOW FEATURES. Nagata, T.; Tohmatsu, T.; Ogawa, T. (Tokyo Univ.). J. Geomagnet. Geoelec.; 20: No. 4, 315-21(1968).

Rocket results are presented on visible and uv dayglow observed in the altitude range of 80 to 350 km for different values of solar-zenith distance. Theoretical interpretations are given on the basis of calculations made for emission rates for various excitation mechanisms and using results of simultaneous measurements of electron density and electron temperature. (auth)

38250 VERTICAL DRIFT VELOCITIES OF THE IONOSPHERIC F REGION DURING THE ECLIPSE OF 12 NOVEMBER 1966. Shimazaki, T.; Laird, A. R. (Ionospheric Telecommunications Lab., Boulder, Colo.). J. Geomagnet. Geoelec.; 20: No. 4, 323-35(1968).

The temporal variation of the electron-density distribution observed by radio soundings at Rio Grande, Brazil during the eclipse of November 1966 was analyzed. Using five models of chemical-reaction coefficients and the lower boundary values of neutral constituents, the variation of an equivalent temperature was calculated. The equivalent temperature is that resulting from a minimization (over a range of heights and times) of the mean-square residual differences between the observed $\partial N/\partial t$ and the values calculated from the continuity equation. The equivalent temperature variations calculated may involve implicitly the effects of diurnal variations in the lower boundary values of neutral constituents and vertical-drift velocities as well as the actual temperature variations. Assuming that the difference of the variation of the equivalent temperature between the eclipse and control day is mainly due to the difference of the vertical drift velocity, the additional vertical-drift velocity on the eclipse day was calculated; it is largely upward and starts to rise about 30 min before the ground eclipse for all five models. A simple model calculation indicates that this additional upward velocity could be caused by the effect of the reduced conductivity in the lower dynamo region during the eclipse. (auth)

38251 CYCLOTRON INSTABILITY OF THE OUTER RADIATION BELT OF THE EARTH UNDER CONDITIONS OF SELF-MODULATION OF GROWING WAVES. Gul'el'mi, A. V. JETP Lett. (USSR) (Engl. Transl.); 13: No. 2, 57-60(20 Jan 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 2, 85-8(20 Jan 1971).

It is assumed that quasi-monochromatic signals propagate in narrow ray tubes. Such tubes are formed at points where the plasmapause crosses the drift shell of the high-energy particles. A property of quasi-monochromatic signals is the fact that they are discrete. An explanation of the manner in which discrete signals are produced by continuous excitation is proposed. (W.D.M.)

38252 SYMPOSIUM ON UPPER ATMOSPHERIC CURRENTS AND ELECTRIC FIELDS, BOULDER, COLORADO, AUGUST 17-21, 1970. Radio Sci.; 6: 131-339(Feb 1971). (CONF-700835).

Twenty-two selected papers are included that were presented at the symposium on ionospheric and magnetospheric electric and magnetic fields. Separate abstracts are presented for 18 papers. (J.C.W.)

For abstracts of individual papers see: 38253-38270.

38253 LONGITUDE AND SEASONAL VARIATIONS OF THE S_q CURRENT SYSTEM. Stening, R. J. (Earth Physics Branch, Energy, Mines, and Resources, Ottawa). Radio Sci.; 6: 133-7 (Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

The equivalent-circuit method of deriving electric currents in the ionosphere from assumed values of conductivities and emf's has been described earlier. The ionosphere is represented as a large circuit network with the Hall effect included, and this network is solved by an iterative procedure on a computer. A single tidal-wind system, the "1, -2" mode, is used as the driving force of the dynamo. The winds are converted from the geographic to the geomagnetic coordinate system. The international geomagnetic reference field (IGRF) is used to provide magnetic field values for calculating the dynamo emf's and the conductivities. The agreement between the calculated and observed positions of the focuses of the current system is remarkable, considering that no seasonal variation of the wind was included. Seasonal variations of the reversal times of the equatorial electrojet are obtained in rough agreement with observation, whereas the calculated variations of the intensity of the electrojet do not agree so well. (auth)

38254 GEOMAGNETIC CROCHETS AND ASSOCIATED IONOSPHERIC CURRENT SYSTEMS. Richmond, A. D.; Venkateswaran, S. V. (Univ. of California, Los Angeles). Radio Sci.; 6: 139-64 (Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

It is shown that time-structure analysis of geomagnetic crochets can be useful in the ground-based detection of xuv radiation from solar flares. The crochets often manifest a composite structure that consists of a fast component presumably produced by euv radiation (100 to 1000 Å) and a slow component produced by soft x rays (1 to 100 Å). This composite structure is taken into account in the proposed method of analysis for crochet current systems. Some preliminary results are given from the simulation studies of S_q and crochet current systems. These studies are in-

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tended to probe into the nature of the atmospheric winds that drive the ionospheric dynamo and that generate both the S_q and crochet currents. (auth)

38255 G_q, A GALACTIC COMPONENT OF THE GEOMAGNETIC FIELD VARIATION. Campbell, W. H. (Environmental Research Labs., Boulder, Colo.); Matsushita, S.; Bender, B. K. Radio Sci.; 6: 165-70(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

A quiet-time galactic component, G_q, of the geomagnetic-field variations was extracted from observatory data of San Juan, Puerto Rico, and Honolulu, Hawaii, for the quiet-Sun years of 1965 and 1966. In the search for this effect, days of active solar–terrestrial disturbances were excluded, and the contributions of the solar-quiet current (S_q) and the lunar-tidal current (L) were first removed. Nighttime data show the G_q most effectively as a 1.5-gamma variation that is diurnal in H with an increase at about 2200 sidereal time. The D and Z sidereal variations are less clear in the present data sample. (auth)

38256 LUNAR TIDE IN f_bE_s. Tarpley, J. D. (Environmental Research Lab., Boulder, Colo.); Matsushita, S. Radio Sci.; 6: 191-6(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

Hourly measurements of the blanketing frequency of sporadic E (f_bE_s) made during 1958–1965 were analyzed for lunar daily variations. The data, which came from ten stations, were analyzed by the Chapman–Miller method. Both seasonal and yearly average lunar variations were obtained. The lunar semidiurnal oscillations in f_bE_s ranged from 0.01 to 0.04 MHz, with maximums occurring from 7 to 9 hours lunar time. The amplitude of the lunar tide in f_bE_s is an order of magnitude less than the lunar variations of f_oE_s. Since f_bE_s is close to the plasma frequency of E_s, the oscillation in f_bE_s represents a lunar variation in the electron density of E_s layers, whereas the significance of the lunar variation of f_oE_s is not clear. The phases of the lunar tides in f_bE_s, f_oE_s, and $h'E_s$ are found to be nearly the same. Two sources of lunar influence on E_s electron density are considered: (1) wind shears in the lunar tide acting to augment or decrease the wind shears responsible for E_s, and (2) interaction of E_s with electrostatic fields associated with the lunar-current system. (auth)

38257 SIMPLE MODELS OF THE LOWER F2 LAYER NEAR THE DIP EQUATOR. VanZandt, T. E.; Clark, W. L. (National Oceanic and Atmospheric Administration, Boulder, Colo.). Radio Sci.; 6: 197-202(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

For the lower F2 layer very near the dip equator, it is assumed that vertical electromagnetic drift is important but that other contributions to the divergence of the ionospheric plasma are not. By also assuming constant scale heights and by making other usual approximations, a continuity equation is obtained that can be solved in terms of tabulated transcendental functions for both day and night. It is shown that these solutions fit very well to electron-density profiles measured by the incoherent-scatter technique near the dip equator; this fit suggests that the assumptions and approximations are suitable. From these fittings, reasonable estimates of the rates of photo-ionization and recombination are obtained. (auth)

38258 E x B DRIFTS AT MIDLATITUDES. Carpenter, L. A.; Bowhill, S. A. (Univ. of Illinois, Urbana). Radio Sci.; 6: 203-7(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

At midlatitudes, vertical transport of ionization in the topside F region results from three mechanisms: first, ambipolar diffusion along the magnetic field; second, interaction between the ionization and the wind in the neutral atmosphere; and third, $E \times B$ drifts perpendicular to the magnetic field. The vertical velocity resulting from these three mechanisms was measured by determining the Doppler shift in the Thomson-scattered power spectrum at altitudes between 450 and 900 km (Evans et al., 1970). Drift measurements were made at Millstone Hill Ionospheric Observatory. Electron-density profiles and electron- and ion-temperature profiles were made also. Drifts for the 24-hour period of September 11–12, 1968, are examined for an altitude of 450 km. The diffusion velocity is calculated from the electron density and the thermal structure; the ion temperature at 300 km is taken as the neutral-gas temperature for determination of the atomic oxygen density. With this diffusion velocity calculated and the vertical velocity measured, the combined effect of interaction with the neutral winds and $E \times B$ drifts can be determined. Through use of a model of the diurnal neutral-wind behavior (Cho and Yeh, 1970), the effective $E \times B$ drift in the topside F region is estimated at midlatitudes. East–west electric fields in the dynamo region that generate such $E \times B$ drifts are calculated from these results. (auth)

38259 HIGH-FREQUENCY HALL-CURRENT INSTABILITY. Lee, K.; Kennel, C. F.; Kindel, J. M. (Univ. of California, Los Angeles). Radio Sci.; 6: 209-13(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

In a partially ionized gas, if electrons and ions have a relative drift V_d perpendicular to a static B field, Farley and Buneman have shown that an electrostatic wave with propagation vector K perpendicular to B and wavelength $\lambda \geq 0.375$ meter will be unstable if $K \cdot V_d/K$ exceeds the ion thermal speed. Farley's calculation for K perpendicular to B was extended. Modes of higher frequencies and shorter wavelengths were examined. The term $K^2\lambda_{DE}^2$ (λ_{DE} is the electron Debye length) was retained, since this term cannot be neglected for short-wavelength modes. This makes the dispersion relation density-dependent. Plots were made of growth rate versus frequency for various values of $K \cdot V_d/K$. With the use of the Culler–Fried on-line computer system, the dispersion relation was solved numerically by contour integration. There are four results of the numerical calculation. First, there is an electron-density threshold for excitation of higher-frequency modes. Second, for a fixed electron density of $3.5 \times 10^5/cm^3$, the fastest-growing mode shifts to higher frequency as $K \cdot V_d/K$ increases. For $K \cdot V_d/K$ equal to three times the ion thermal speed, $3a_I$, the fastest-growing mode oscillates at $\omega_r \simeq 0.7\,(\Omega_E\,\Omega_I)^{1/2}$, where Ω_E and Ω_I are electron and ion-cyclotron frequencies. The frequency ω_r is far above those calculated by Farley. Third, the same behavior cited above is also exhibited for fixed $K \cdot V_d/K$ but increasing electron density. Fourth, modes with oscillating frequency $\omega_r \simeq (\Omega_E\,\Omega_I)^{1/2}$ can be excited for $K \cdot V_d/K \geq 2.3a_I$ and current density greater than 1.0×10^{-5} amp/m^2. These are reasonable values for the equatorial electrojet and the auroral electrojet in the ionosphere during disturbed times. (auth)

38260 NONLINEAR COLLISIONLESS PLASMA WAVES AND INTENSITY OF THE ELECTRIC FIELD OF THE IONOSPHERIC IRREGULARITIES. Prasad, B. (Air Force Cambridge Research Labs., Bedford, Mass.); Sen, Hari K.; Bakshi, P.; Kalman, G. Radio Sci.; 6: 215-19(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

An exact longitudinal-wave solution of nonlinear equations for a cold and collisionless one-fluid magnetoplasma was obtained. The wave is found to be anharmonic (non-sinusoidal) in form and its amplitude involves an arbitrary parameter. By means of a pseudo-potential well, the domain of nonlinear oscillations is defined and the maximum amplitude up to which a nonlinear wave can grow is determined. Intensity of the equatorial sporadic-E irregularities is computed and the coherent-energy density is found to be of the order of 10^{-9} erg/cm^3. (auth)

38261 LINEAR ANALYSIS OF THE FORMATION OF FIELD-ALIGNED STRIATIONS IN PLASMA CLOUDS DUE TO CROSS-FIELD INSTABILITY. Rao, P. B.; Russell, W. H. (Raytheon Co., Burlington, Mass.). Radio Sci.; 6: 221-32(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

A weakly ionized plasma with gradients in the ionization density under the influence of the crossed electric and magnetic fields is subject to a unique type of plasma instability called the cross-field or $E \times B$ instability. From a linear analysis, the relevance is examined of such an instability mechanism to the formation of the field-aligned columns of enhanced ionization or striations in the artificially generated plasma clouds in the upper atmosphere. A Gaussian model for the electron-density distribution in the cloud and the electric fields that have been derived from the ion and neutral cloud-drift motions are used in computing the characteristic parameters, the minimum wavelength λ_{min} and the e-folding growth time τ for the instability. A brief comparison shows good agreement between the computed instability model and the observed striation formation in one of the high-latitude barium releases conducted in Alaska during March 1969 (test hemlock of Secede III series). Some general results that show the dependence of the instability parameters on the height of the release and cloud dimension are also presented. (auth)

38262 SIMULTANEOUS ELECTRIC FIELD MEASUREMENTS MADE IN THE AURORAL IONOSPHERE BY USING THREE INDEPENDENT TECHNIQUES. Fahleson, U. (Royal Inst. of Tech., Stockholm); Faelthammar, C.-G.; Pedersen, A.; (and others). Radio Sci.; 6: 233-245(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

Two Skylark rockets were launched from the range of the European Space Research Organization (ESRO) near Kiruna on February 14, 1970, at 17.15 CET and on April 2 at 02.46 for investigation of electric fields. Each rocket carried an electric double-probe experiment, a Langmuir probe, an experiment to detect the influence of the plasma drift on the wake of the rocket, a Geiger–Mueller counter, and finally, a barium cloud experiment. Three of these (double-probe, wake experiment, and barium cloud) provided independent information on the ambient electric field. The present paper deals with the initial results of these three electric field experiments. In the first flight, which took place under slightly disturbed conditions (+40 γ), all methods indicated a roughly northerly field of about 22 mV/m. In the second flight (under quiet conditions), a southerly field between 3 and 6 mV/m was observed by the different experiments. The direction of the plasma drift derived from the measured orientation of the wake of the rocket agrees within 10° with that derived from the double-probe results and the barium cloud observations. Estimates of electron density and temperature were obtained from the operation of the double-probe system in different modes. These electron-density values were in good agreement with those derived from the ionosonde data and from the Langmuir-probe data. (auth)

38263 CALCULATION OF AN EQUIVALENT CURRENT SYSTEM IN THE POLAR E REGION. Czechowsky, P. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Radio Sci.; 6: 247-53 (Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

In order to interpret vhf aurora-backscatter communications, it is necessary to get some information about the extent, the movement, and the strength of the polar electrojet. In this paper, a method is given to calculate an equivalent current system in the polar E region by determining the unknown parameters (height, direction, width of the current, etc.) from the measured-disturbance vectors of the Earth's magnetic field, ΔH, ΔD, and ΔZ. With a model of a simple current-density distribution it is possible to solve the Biot–Savart formula. The consideration of positive, negative, and induced currents leads to a system of nonlinear equations of eight unknown parameters in this special instance. With an iterative method given by Newton and Raphson, this system of equations can be solved if approximate values of the solution are known. These approximate values are given by physical conditions or can be obtained by model calculation. Results are shown for a current system calculated with values of ΔH, ΔD, and ΔZ from the magnetograms of Leirvogur, Lerwick, Eskdalemuir, and Hartland during a period of about five hours on March 23–24, 1969. (auth)

38264 HOURLY CHANGES IN CONJUGATE LOCATION DETERMINED FROM ABSORPTION AND FIELD DATA. Campbell, W. H. (Environmental Research Labs., Boulder, Colo.). Radio Sci.; 6: 255-67(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

The ionospheric absorption detected by five-riometer arrays and the concurrent magnetometer records from Great Whale River, Canada, and Byrd, Antarctica, were studied during mildly active periods of August 23, 1966, and April 24, 1967. Through use of the four methods of absorption-gradient variation, correlated absorption region, triangulated current, and field-pulsation patterns, evidence of hourly change in apparent conjugate location was sought. The riometer data showed analogous changes in the two hemispheres but rather random variations in conjugate position. The field-pulsation patterns were not interpretable. The relative north–south position of the auroral electrojets from the two stations indicated a regular change in the outer magnetosphere, which probably caused a variation in the conjugate location. (auth)

38265 ELECTRIC CURRENT SYSTEMS FOR POLAR SUBSTORMS AND THEIR MAGNETIC EFFECT BELOW AND ABOVE THE IONOSPHERE. Fukushima, Naoshi. (Tokyo Univ.). Radio Sci.; 6: 269-75(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

For polar magnetic substorms, the two-dimensional current system in the ionosphere and the three-dimensional systems including the field-aligned currents in the magnetosphere are conjectured; both systems have the same geomagnetic effect on the ground but a different effect in and above the ionosphere. The intense westward electrojet along the auroral zone, or oval, is concluded to be mainly the Hall current in the ionosphere, and this is always accompanied by the field-aligned current system in the meridional plane with a north–south current segment in the ionosphere. The direction of current flow in the meridional plane depends on the mechanism of its production, whether it is of ionospheric origin or of magnetospheric origin. Recent rocket and satellite measurements of the magnetic field in and above the ionosphere indicate the presence of both of these conditions. (auth)

38266 INTERACTIONS BETWEEN THE IONOSPHERE AND THE MAGNETOSPHERE FOR S_q AND L VARIATIONS. Matsushita, S. (National Center for Atmospheric Research, Boulder, Colo.). Radio Sci.; 6: 279-94(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

After a short discussion of the dynamo theory for producing electric-current systems for S_q and L variations, results of mapping these dynamo-region electrostatic fields into the magnetosphere are briefly presented. The mapped electrostatic fields, together with the Earth's main magnetic field, produce drift motions of magnetospheric plasma particles. Using the same but reversed mapping procedure, magnetospheric electrostatic-field effects on the dynamo region are discussed. Highly localized geomagnetic variations during relatively quiet periods can be explained by this effect. Also, a possibility of producing S_q-type electric currents in the dynamo region by the magnetospheric electrostatic fields caused by motions in the plasmasphere is examined. This magnetospheric effect on S_q may be greater than other effects due to magnetospheric electric currents (such as magnetopause, tail, and quiet-ring currents). It is concluded that future direct measurements of electrostatic fields (or electrostatic drifts) may determine which of the two mechanisms (dynamo action or plasmaspheric motions) is the major cause of the production of the ionospheric S_q current system, although the dynamo action seems to be the main cause of L variation. (auth)

38267 FORMATION BY ELECTRIC FIELDS OF FIELD-ALIGNED IRREGULARITIES IN THE MAGNETOSPHERE. Park, C. G.; Helliwell, R. A. (Stanford Univ., Calif.). Radio Sci.; 6: 299-304(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

A possible mechanism for the formation of electron-density irregularities in the magnetosphere is examined quantitatively. The mechanism involves localized $E \times B$ convection cells in which tubes of ionization with different total content are mixed. Under reasonable initial conditions, it is shown that a 0.1-mV/m electric field in the equatorial plane can produce electron density enhancements and depressions of the order of 5% at $L = 4$ in about one-half hour. These enhancements are large enough to trap whistler waves, whereas the depressions can trap hf waves. It is also shown that small-scale density irregularities can be produced by a much-larger-scale electric field. It is suggested that thundercloud electricity may be a possible source of the electric field responsible for the irregularities. (auth)

38268 PLASMA SHEET CONVECTION VELOCITIES INFERRED FROM ELECTRON FLUX MEASUREMENTS AT SYNCHRONOUS ALTITUDE. Shelley, E. G.; Johnson, R. G.; Sharp, R. D. (Lockheed Palo Alto Research Labs., Palo Alto, Calif.). Radio Sci.; 6: 305-13(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

Large increases in the low-energy electron fluxes (0.5 to 50 keV) are observed to occur at synchronous altitude on most nights in the local evening or midnight sectors. These increases are usually found to be associated with magnetic substorms. The time of increase in the fluxes is found to be energy-dependent, with the lower-energy electrons nearly always being observed first for the evening and midnight events. If one interprets these flux increases as resulting from an inward convection of the plasma sheet in connection with a substorm, one can estimate the convection velocity at synchronous altitude from the measured energy-dependent time of flux increase and earlier measurements [Vasyliunas, 1968; Schield and Frank, 1970; Frank, 1970] of the energy-dependent radial structure of the inner edge of the plasma sheet. The median velocity estimated from 38 cases by this technique is approximately 3 km/sec. This implies a westward electric field of approximately 0.36 mV/m, a value consistent with other measurements of this field. (auth)

38269 DUNGEY MODEL OF THE MAGNETOSPHERE AND ASTRO-GEOPHYSICAL CURRENT SHEETS. Speiser, Theodore W. (Univ. of Colorado, Boulder). Radio Sci.; 6: 315-19(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

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By the addition of an interplanetary magnetic field in various orientations to a closed magnetosphere model, the Dungey model was generated for all orientations other than a strictly northward interplanetary magnetic field. Particles can be accelerated in both the dayside magnetopause-current sheet and in the tail-current sheet, but there are inherent asymmetries. Particles may have asymmetric access to the north or the south polar caps, depending on the interplanetary field orientation. The breakdown of the usual adiabatic theory is discussed for a model current sheet. (auth)

38270 MODEL OF THE GEOMAGNETIC CAVITY. Coleman, Paul J. Jr. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). Radio Sci.; 6: 321-39(Feb 1971).

From Symposium on Upper Atmospheric Currents and Electric Fields, Boulder, Colo. See CONF-700835.

Previously (1970) the author stated that the behavior of a perfectly conducting (nonresistive) fluid in electrical contact with, and moving relative to, a resistive magnetized fluid is similar in many ways to the behavior of a fluid with nonzero resistivity. In particular, the effect of unipolar induction produced by the relative motion is basically the same in both cases, provided only that the total resistance to the flow of the unipolar induction current is the same in both. It was then concluded that solar-wind plasma in the boundary layer at the magnetopause must drive currents through the ionosphere by unipolar induction and that this process can, in principle, operate in a steady state. It was shown that the electromagnetic forces of the unipolar induction current produce a tangential drag on the geomagnetic cavity and suggested that this drag is sufficient to drive the convection of magnetospheric plasma and to produce the geomagnetic tail. Here, the geomagnetic cavity that should exist if the required tangential drag is produced by unipolar induction is described qualitatively; a heuristic model of such a cavity is introduced. (J.C.W.)

38271 PITCH-ANGLE DIFFUSION OF ELECTRONS IN A GLOW AURORA. Courtier, G. M.; Bennett, G.; Bryant, D. A. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys.; 33: No. 6, 847-58(Jun 1971).

Intensities of electrons with energies E (>45 keV and E > 110 keV were measured on the Petrel sounding rocket P23K, launched from Esrange, Sweden on February 11, 1969 into a post-breakup auroral glow. The shape of the pitch-angle distribution was found to depend on the electron intensity, the dependence being shown most clearly by a strong correlation between the electron intensity at a pitch angle of 75° and the intensity at a pitch angle of 35°. The relation between the intensities at 75° and 35° was found to be the same for electrons with E > 45 keV as for electrons with E > 110 keV when the intensities were normalized. The pitch-angle distributions were usually different for the two energies, with the higher-energy electrons being more anisotropic. The observations are interpreted in terms of pitch-angle diffusion of electrons into the loss cone from a reservoir of trapped electrons with approximately the same constant intensity on all lines of force sampled during the rocket flight. A given degree of anisotropy is translated into an rms angle of scattering for electrons traversing a diffusion region assumed to be near the geomagnetic equator on the local magnetic field line. The energy dependence of the diffusion process is examined, and the energy spectrum of the trapped electrons, their lifetime, and the extent of the reservoir of trapped electrons are discussed. (auth) (UK)

38272 EQUATORIAL MODULATION OF ELECTRONS IN A PULSATING AURORA. Bryant, D. A.; Courtier, G. M.; Bennett, G. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys.; 33: No. 6, 859-67(Jun 1971).

Electron intensities at 4, 6, and >22 keV were measured on the ESRO Skylark rocket S29/2 launched into a pulsating aurora from Kiruna, Sweden on October 17, 1969. The similarity of pulsations in electron intensity at the rocket and optical intensity seen from the ground showed that the pulsations were true temporal changes over part of the flight. The time dispersion between the pulsations at different electron energies places the source of the modulation at a distance $(4 \pm 1) \times 10^4$ km from the ionosphere, i.e., within about 10^4 km of the geomagnetic equator on the L = 5.4 magnetic shell. The modulation process was found to be coherent to within 1 sec over a radial distance at the equator of at least 500 km. (auth) (UK)

38273 IONOSPHERIC ABSORPTION OF DOWNGOING WHISTLER WAVES DURING NIGHTTIME. Thomas, L.; Horowitz, S. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys.; 33: No. 6, 879-88(Jun 1971).

A full-wave method is used to examine the transmission and internal reflection of waves incident on the nighttime ionosphere from above at moderate and low latitudes. The results are used to examine how the absorption of whistler waves incident vertically varies with height. Calculations for a range of angles at which the whistler waves emerge into free space below the ionosphere indicate how ionospheric absorption influences the latitude variation of whistler occurrence and affects the whistler energy spectra observed at different latitudes. (auth) (UK)

38274 INTERNAL REFLECTION OF WHISTLER WAVES IN THE LOWER IONOSPHERE. Thomas, L.; Smeathers, J. R. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys.; 33: No. 6, 959-62(Jun 1971).

A full-wave method is used to examine the internal reflection of vlf radio waves incident from above on a model of the nighttime lower ionosphere. Particular attention is paid to the changes occurring as the wave-normal direction move outside the acceptance cone for penetration to the Earth's surface. (auth) (UK)

38275 VLF PHASE ANOMALIES DUE TO A SOLAR X-RAY FLARE. Jones, T. B. (Univ. of Leicester, Eng.). J. Atmos. Terrest. Phys.; 33: No. 6, 963-5(Jun 1971).

During the Class 2 flare at 12.50 UT Dec. 1, 1967, disturbances were observed in the phase of a number of vlf radio signals monitored at Leicester. Marked structure was evident in the phase anomalies. The x-ray spectrum during the flare was monitored with high wavelength and time resolution by the detectors aboard the OSO-4 satellite, and the phase fluctuations appeared to be correlated with the x-ray flux variations in the 1- to 3-Å band. It seems likely, therefore, that changes in the ionization density below the vlf reflection levels were of sufficient magnitude to allow the fine structure of the flare burst to be observed by radio methods. The phase recovery rates differed for the long and short propagation paths monitored and the phase anomaly on the long path persisted even after the x-ray flux had returned to its pre-flare value. This suggests a relatively slow recombination rate for the flare-enhanced ionization in the lowest region of the ionosphere from which these waves were reflected. (auth) (UK)

38276 STUDY OF POLAR-SUBSTORM-RELATED TRAVELING IONOSPHERIC DISTURBANCES BASED ON COLUMNAR ELECTRON CONTENT MEASUREMENTS. Davis, Michael James. Stanford, Calif.; Stanford Univ. (1970). 143p. University Microfilms Order No. 71-12,880.

Thesis.

A detailed study of a particular type of traveling ionospheric disturbance (TID) was carried out using columnar electron-content data. The disturbance is characterized by an occurrence related to the degree of geomagnetic activity, a high rate of travel (near 500 m s^{-1}) from the polar regions toward the equator, and the retention of its character over distances of the order of 1000 km. A detailed picture of the morphology of these disturbances is presented, and their behavior is related to a separate pattern of geophysical activity, namely, the occurrence of polar substorms. These disturbances exhibit a diurnal variation in their direction of arrival at a midlatitude observing site, that can be explained in terms of an average source location fixed in local dipole time and dipole latitude and which is in the evening sector of the auroral oval. These disturbances are not generally observed to travel across the equator. This lack of transequatorial propagation is explained on the basis of the high rate of damping of the disturbances in the neutral atmosphere which produce them. (TSS) (Diss. Abstr. Int., B)

38277 LOCATION OF SOURCES OF ELF NOISE IN THE EARTH–IONOSPHERE CAVITY BY ANALYSIS OF SCHUMANN SPECTRA. Toomey, John Patrick. Kingston, R. I.; Univ. of Rhode Island (1970). 169p. University Microfilms Order No. 71-12,803.

Thesis.

Experimental techniques for the measurement of natural elf electromagnetic noise are described, including methods for absolute calibration of magnetic and electric-field sensors in this frequency range (3 to 30 Hz). After a review of the theory applicable to Earth–ionosphere cavity resonances a method is developed which permits location of two simultaneously active, major thunderstorm regions on the surface of the Earth by analysis of elf spectra. Use is made of electric- to magnetic-field ratios and of ratios involving the power-spectrum magnitudes at adjacent resonant peaks. Limitations of the method are analyzed, particular those related to $f^{-\alpha}$ background noise (f = frequency) and to quasi-uniformly distributed, minor lightning activity which adds to the noise originating in the major thunderstorm regions. Appropriate methods of spectral analysis — appropriate frequency resolutions and integration times — are determined and the method is illustrated by experimental data. It is indicated how

the source location procedure may be used to evaluate ionospheric conductivity profiles extending downward to about 40 km. (Diss. Abstr. Int., B)

38278 WHISTLER STUDY OF THE INTERCHANGE OF IONIZATION BETWEEN THE IONOSPHERE AND THE PROTONOSPHERE. Park, Chung Gun. Stanford, Calif.; Stanford Univ. (1970). 78p. University Microfilms Order No. 71-12,971.
Thesis.

Whistlers recorded at Eights, Antarctica in June, 1965 were used to measure the electron content in magnetospheric tubes of force in the range $3.5 < L < 5$. Under quiet geomagnetic conditions, the observed rate of increase in daytime tube content gives an upward flux of $\sim 3 \times 10^8$ electrons/cm^2-sec across the 1000-km level, which is larger than the downward flux necessary to maintain the nocturnal ionosphere. The observed upward flux is primarily due to diffusion of protons through the diffusive barrier rather than to an increase in the height of the barrier. The downward flux at night under quiet conditions, is $\sim 1.5 \times 10^8$ electrons/cm^2-sec, an amount that is considered sufficient to maintain the nocturnal ionosphere. The protonosphere is depleted in less than a day during a magnetic storm or intense polar-substorm activities, and subsequent recovery of tube content takes place at a rate of 3 to 5×10^{12} electrons/cm^2 per day. The average spacing of geomagnetic disturbances is such that the protonosphere is expected almost never to reach the saturation level that would be attained if it were in equilibrium with the ionosphere. (TSS) (Diss. Abstr. Int., B)

38279 GENETIC CLASSIFICATION OF Pc3 AND Pc4 GEOMAGNETIC PULSATIONS AT MIDLATITUDES. Ng, Tai Ping. Vancouver; Univ. of British Columbia (1970). National Library of Canada, Ottawa.
Thesis.

Dynamic spectra processed from data recorded on magnetic tape at the midlatitude Ralston station (Alberta) in 1967 were studied. The Pc3, 4 pulsations appear to behave in a much more complicated manner than reported by other observers at low-latitude stations. The variation of the Pc3, 4 frequency at Ralston assumes different forms from one day to another, the pattern depending largely upon the general level of magnetic disturbance represented by the K_p index. Most of the Pc3, 4 spectra analyzed may be classified into one of, or a combination of, four well-defined diurnal patterns under steady magnetospheric conditions. The crux of the present interpretation is that Ralston, under moderate magnetospheric agitation, may pick up micropulsation activities originating from the plasmasphere and/or the plasma trough depending upon its position relative to the plasmapause. Eigen oscillations of modified Alfvén mode (poloidal oscillation) in these two magnetospheric regions are considered to be the prime sources of the ground observed Pc3,4 magnetic pulsations. (TSS) (Diss. Abstr. Int., B)

38280 SIMULTANEOUS MEASUREMENTS OF IONOSPHERIC DRIFTS BY VERTICAL AND OBLIQUE SOUNDING. Kokourov, V. D.; Kazimirovskii, E. S.; Zakharov, V. N.; Jovty, E. I. (Siberian Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). J. Atmos. Terrest. Phys.; 33: No. 6, 943-50(Jun 1971).

The measurement of ionospheric drifts was carried out during the period 1968–69 by the close-spaced receiver method (2.2 MHz) operating simultaneously at vertical and slightly oblique incidence. The observing sites were separated by about 100 km. The horizontal drift velocity was evaluated by the method of similar fades. The statistical drift patterns at the two sites were in agreement with the well-known patterns of general atmospheric circulation at ionospheric levels. Differences were noted, however, in the character of the averaged diurnal variations of the E–W and N–S drifts from the two sites. Even so, and in spite of the fact that the spacing of the reflection points was about 50 km in the horizontal direction, the drift speeds and directions obtained at the two sites simultaneously agreed reasonably well. (auth) (UK)

38281 SOLAR-ACTIVITY AND LATITUDINAL CHARACTERISTICS OF THE SEASONAL, NONSEASONAL, AND SEMI-ANNUAL VARIATIONS IN THE PEAK ELECTRON DENSITIES OF THE F2 LAYER AT NOON AND AT MIDNIGHT IN MIDDLE AND LOW LATITUDES. Yonezawa, T. (Radio Research Labs., Tokyo). J. Atmos. Terrest. Phys.; 33: No. 6, 889-907(Jun 1971).

The F2-layer peak electron density variation is expressed, for a fixed local time, as a superposition of the seasonal, nonseasonal, and semi-annual components. The annual mean and its observed values at noon and at midnight in middle and low latitudes (including the equatorial zone) are analysed to reveal the solar-activity and latitudinal characteristics of the three components. (auth) (UK)

38282 SIMULTANEOUS MEASUREMENTS OF ELECTRONIC DENSITY USING TOPSIDE SOUNDINGS AND INCOHERENT SCATTER SOUNDINGS. Fleury, L.; Taieb, C. (CNET-GRI, Issy-les-Moulineaux, France). J. Atmos. Terrest. Phys.; 33: No. 6, 909-18(Jun 1971).

Electron-density measurements obtained from ISIS satellite topside soundings are compared with incoherent-scatter measurements at St. Santin, and the data are critically analysed. Most of the topside profiles agree with incoherent-scatter profiles. Some of them that disagree are discussed and it is concluded that they are due to oblique propagation. (auth) (UK)

38283 MAGNETOSPHERE. Oberc, Pawel (Univ., Warsaw). Acta Geophys. Pol.; 18: No. 1, 103-41(1970). (In Polish).

The phenomena related to the existence of the magnetosphere are explained. The first part of the work gives the results from observations and explains the observational methods. Then results are presented from magnetic-storm data, aurora-borealis data, as well as the physical conditions in the magnetosphere made from satellite soundings. The next part explains the theoretical hypotheses. Considerations are made of the direction of the solar wind at the edge of the magnetosphere from the magnetospheric configuration. Radiation zones are then studied. The theories of the radiation zones are explained. The present theories concerning the origin of the magnetic aurora and aurora borealis are presented. (tr-auth)

Low-Temperature Physics and Cryogenic Equipment

Superfluidity

38284 STABILITY OF A VORTEX LATTICE IN THE PRESENCE OF A SUPERFLOW. Le Ray, M.; Francois, M. (Faculte des Sciences, Orsay, France). Phys. Lett.; 34A: 431-2(19 Apr 1971).

Experimental evidence is given of the prominent role played by shear waves and the coupling of vortices by superflow in the stability of the lattice. Experiments are performed with flow at various angles to the vortices. (auth)

38285 NONLINEAR WAVES IN THE PITAEVSKII-GROSS EQUATION. Tsuzuki, Toshio (Institut Max von Laue-Paul Langevin, Garching, Ger.). J. Low Temp. Phys.; 4: No. 4, 441-57(Apr 1971).

Nonlinear waves, solitary and periodic, are studied exactly in the Pitaevskii–Gross equation for the wave function of the condensate of a superfluid. Also, the relationship between these two waves and Bogolyubov's phonon and the energies associated with these waves are studied. The creation energy of a solitary wave with amplitude A is proportional to A^3. Solitary waves show interesting behavior on their collision due to their localized character. The effect of collision on solitary waves can be described by the phase shift. A formula of the phase shift in a collision of two solitary waves is given. The decay of an arbitrary initial disturbance into solitary waves is discussed further. (auth)

38286 THEORY OF VORTEX LINES IN LIQUID ^{4}He. Lekner, J. (Cavendish Lab., Cambridge, Eng.). Progr. Theor. Phys. (Kyoto); 45: No. 1, 42-9(Jan 1971).

An integro-differential equation for the function characterizing the structure of a vortex line is obtained from a variational calculation. Certain approximations enable this function to be determined purely in terms of the pair correlation function of the fluid at rest. The trapping of ^{3}He atoms by vortex lines in ^{4}He is also discussed, and is reduced to the solution of a Schroedinger equation with an effective radial potential. (auth)

38287 SURFACE STRUCTURE OF LIQUID ^{4}He. Lekner, J. (Cavendish Lab., Cambridge, Eng.). Progr. Theor. Phys. (Kyoto); 45: No. 1, 36-41(Jan 1971).

A wave function for liquid ^{4}He with a surface is constructed, and a variational calculation to minimize the additional surface energy gives an integro-differential equation for the function characterizing the surface. The surface structure can be determined in terms of bulk properties provided certain approximations are made for the density and pair correlation functions near the surface. (auth)

38288 DISSIPATION IN SUPERFLUID HELIUM FLOW. Williams, David Ronald. Los Angeles; Univ. of California (1970). 144p. University Microfilms Order No. 71-10,654.
Thesis.

The superfluid density was measured as a function of tempera-

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ture in a packed-powder superleak by a Helmholtz-resonance technique. Independently, the mass flow rate of He II through the superleak was determined as a function of the chemical potential driving force. The results of these two experiments are in agreement with the Langer and Fisher theory of superfluid dissipation in the general case of nonisothermal flow. It is found that the superfluid density used in the expression for the dissipation force must be the one measured in the superleak. The chemical potential driving force is obtained by measuring both the pressure and temperature across the superleak. (Diss. Abstr. Int., B)

38289 COUPLING BETWEEN PRESSURE AND TEMPERATURE WAVES IN LIQUID HELIUM. Fritz, Garold Frederic. East Lansing, Mich.; Michigan State Univ. (1970). 99p. University Microfilms Order No. 71-11,841.

Thesis.

When the thermal expansion coefficient, α, is retained in the linearized hydrodynamic equations of the two-fluid model of superfluid liquid helium, pressure and temperature waves are not independent. Thus, a periodically varying temperature source produces not only temperature waves in liquid helium, but also two pressure waves, p_1' and p_2', which propagate at the velocity of first and second sound, respectively. Similarly, a vibrating diaphragm produces not only pressure waves but also two temperature waves, T_1' and T_2', which also propagate at the velocity of first and second sound, respectively. Lifshitz has shown that the amplitudes of these cross modes should be proportional to α. This coupling was investigated by observing and studying the two pressure waves p_1' and p_2' produced by a heater and the temperature wave T_2' produced by a capacitor microphone. The temperature dependence of the amplitude of these waves was studied, using both pulse- and standing-wave techniques in the temperature range from 1.2 K to the λ-point. Good agreement with theory resulted only for the p_1' mode. (Diss. Abstr. Int., B)

38290 THEORETICAL STUDIES OF THE PROPAGATION OF SOUND IN NARROW CHANNELS FILLED WITH HELIUM II. I. THE DISPERSION RELATIONS OF FOURTH SOUND AND OF THE FIFTH WAVE MODE. Wiechert, H.; Meinhold-Heerlein, L. (Univ., Mainz). J. Low Temp. Phys.; 4: No. 3, 273-88(Mar 1971).

The wave propagation in helium II bounded by two plane-parallel plates forming a narrow channel is considered. The theory is based on the complete linearized set of the Khalatnikov equations. These equations are exactly averaged over the width of the channel, taking into account the boundary conditions and symmetry relations. It is shown that, in narrow channels, three solutions of these equations exist: (a) fourth sound, (b) the so-called fifth-wave mode, and (c) another wave mode, which is very strongly damped. The dispersion relations of these wave modes are calculated with regard to all kinetic coefficients and to the coefficient of thermal expansion. The phase velocities and absorption coefficients are also discussed in detail. (auth)

38291 SPIN DIFFUSION OF ^{3}He IN DILUTE MIXTURES OF ^{3}He IN SUPERFLUID ^{4}He. Biegelsen, David Kalman. St. Louis; Washington Univ. (1970). 104p. University Microfilms Order No. 71-11,025.

Thesis.

An experimental investigation of the spin diffusion of ^{3}He atoms in dilute ^{3}He/^{4}He mixtures is described. The thermodynamic parameters of the samples are varied within the following limits: $0.3° \leq T \leq 1.15°K$, $svp \leq P \leq 24$ atm., $0.322 \times 10^{-4} \leq n_3 \leq 4.54 \times 10^{-4}$ mole/cc. It is shown that all samples considered are within the limits of the semiclassical regime. A discussion of the plausibility of assuming that the effective mass of a ^{3}He quasi particle is m_{30}^* (the $n_3 \to 0$ limit of $m_3^*(n_3)$) is given. The theory relating the spin diffusion, as measured in a pulsed nuclear magnetic resonance experiment, to the effective inter-quasi-particle interaction is developed. The data are analyzed by considering the reciprocal of the diffusion to be the sum of two parts: $\{[1/D(T,P,n_3)] = [1/D_{3\rho}(T,P)] + [1/D_{33}(T,P,n_3)]\}$, where $D(T,P,n_3)$ is an experimental measurement at (T,P,n_3), $D_{3\rho}(T,P)$ is the n_3-independent spin diffusion of a ^{3}He quasiparticle as limited by interactions with rotons, and $D_{33}(T,P,n_3)$ is the spin diffusion of a ^{3}He quasiparticle limited by interactions with other ^{3}He quasiparticles. Since $D_{3\rho}$ is independent of n_3 and D_{33} is shown to be proportional to n_3^{-1}, a least-squares fit of the data to the above equation gives the experimentally determined values of $D_{3\rho}$ and D_{33}. A comparison of D_{33} with the theoretical expression gives directly the moment of the effective interaction measured by spin diffusion in the semiclassical regime: $\langle V(k)\rangle|_{T,P} = A\int e^{-ak^2} k^3 |V(bk)|^2\, dk$, where A, a and b are constants. The measurements are insufficient to determine V(k) uniquely. Calculations using an assumed interaction (which reduces to the interaction determined by Ebner at SVP) show a remarkable similarity to the experimental data. (Diss. Abstr. Int., B)

38292 SUM RULES, DYNAMIC FORM FACTOR, AND ELEMENTARY EXCITATIONS IN LIQUID ^{4}He. Hall, D.; Feenberg, E. (Washington Univ., St. Louis). Ann. Phys. (N. Y.); 63: No. 2, 335-60(Apr 1971).

Topics covered are: the upper and lower limits on $1/N\ \langle 0|\rho_{-k}(H - E_0)^{-1}\rho_k|0\rangle$, the two-component formulation of the sum rules, and an upper limit on the energy of an elementary excitation. (M.H.R.)

Superconductivity

38293 (IS-T-436) ELECTRON TUNNELING MEASUREMENTS ON PURE BULK THORIUM. Haskell, Brent Alan (Ames Lab., Iowa). Jun 1971. Contract W-7405-eng-82. 98p. Dep. NTIS.

Thesis.

Electron tunneling measurements were performed on pure bulk thorium samples over the temperature range 0.3 to 1.4°K. The data for most of the tunnel junctions were corrected for the presence of an unexplained parallel conductance mechanism. An apparent correlation exists between the electron tunneling results and the crystalline structure of the thorium in the junction region. Thorium samples of a given type of crystallinity display very similar $(di/dv)_{v=0}$ vs reduced temperature curves. The actual di/dv vs v curves for these samples also are very similar, although discrepancies are present for bias voltages corresponding to energies greater than half the value of the energy gap. A two-energy gap analysis seems appropriate for single-crystal and partly single samples, while polycrystalline samples show a single-gap BCS-like behavior. Entire differential conductance curves were calculated, assuming a BCS density of states for junctions typical of each type of crystalline structure. The results are discussed in terms of existing theories of two-energy band metals and in terms of previous experimental data for thorium. (auth)

38294 NOTE ON SUPERCONDUCTIVITY OF THE EXCITONIC INSULATOR. Parmenter, R. H. (Univ. of Arizona, Tucson). Phys. Lett.; 34A: 432-3(19 Apr 1971).

The superconductive properties of the excitonic insulator are discussed. The conclusion of Kohn and Sherrington that the excitonic insulator cannot superconduct is shown to be invalid. (auth)

38295 IMPROVEMENT OF SUPERCONDUCTING Nb CAVITIES BY ANODIC OXIDE FILMS. Martens, H.; Diepers, H.; Sun, R. K. (Siemens AG, Erlangen, Ger.). Phys. Lett.; 34A: 439-40(19 Apr 1971).

Measurements were made on superconducting Nb cavities in the TE_{011} mode at 9.5 GHz. By anodic oxidation of the surfaces it was found possible to increase considerably both the Q values and the critical magnetic field. (auth)

38296 G-L BEHAVIOR OF TWO-DIMENSIONAL Al FILMS BELOW T_c. Cerdonio, M.; Di Leo, T.; Lucano, G. (Univ. of Rome). Phys. Lett.; 34A: 441-2(19 Apr 1971).

The temperature dependence of fluxoid and of critical currents was measured very near T_c for thin Al hollow cylinders using sensitive flux-trapping techniques; remarkable agreement with G-L theory is found despite two-dimensional experimental conditions. (auth)

38297 SUPERCONDUCTIVITY AND ANNEALING BEHAVIOR OF QUENCHED GERMANIUM–NOBLE METAL ALLOY FILMS. Stritzker, B.; Wuehl, H. (Univ., Karlsruhe, Ger.). Z. Phys.; 243: 361-72(1971).

Thin films of Ge-Cu, Ge-Ag and Ge-Au alloys were condensed onto substrates held at 4°K. An amorphous, metallic phase was obtained. The superconductivity of this phase is believed to be due to Ge, which is forced into a liquid-like structure with a higher coordination number than that of the semiconducting diamond structure. The maximum transition temperatures of the Ge-Cu and Ge-Au films are 3.3 and 3.6°K, respectively, whereas Ge-Ag films show a maximum T_c of 1.2°K. The difference in T_c is explained by the band structure of the noble metals. (auth)

38298 FLUCTUATION ENHANCED CONDUCTIVITY OF A SUPERCONDUCTOR: THE CORRECT EVALUATION OF THE MAKI GRAPH. Schmid, Albert (Univ., Karlsruhe, Ger.). Z. Phys.; 243: 346-60(1971).

According to Maki, a particular diagram — the Maki graph — gives a contribution to the fluctuation-enhanced conductivity of a superconductor, which is infinite in the case of a thin film. It is shown that this result is spurious and that it is due to a breakdown of the standard Green function impurity technique. A new method is developed that is strictly based on the Boltzmann

equation. It is shown that the temperature-dependent contribution of the Maki graph to the conductivity is negligibly small in a dirty metal. (auth)

38299 PENETRATION OF THE MAGNETIC FIELD INTO A SUPERCONDUCTOR. Halbritter, J. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys.: 243: 201-19(1971).

It is known that in superconductors the exponential decay of the magnetic field is an approximation, which breaks down if the dimension of a Cooper pair ξ_F is of the order or smaller than the London penetration depth δ. The appearance of a nonlocal relation between current and field yields deviations from the exponential decay especially a sign reversal of the field at a certain distance. This sign reversal is associated with a change of the surface energy in superconductors and of the structure of fluxoids together with their interaction. Results are presented on the magnetic field decay, which is calculated from the exact BCS integral kernel for weak fields. As a result, the nonlocal effects in the framework of BCS theory can be described in good approximation by the ratio of the London penetration depth $\delta(T,l)$ and the dimension of Cooper pairs $\xi_F(T,l)$. The evaluations show that one still has sign reversal, i.e., large nonlocal effects, in Type II superconductors with a $\kappa(T) \lesssim 1.6$. It should be mentioned that the limit $\kappa \lesssim 1.6$ coincides roughly with the experimentally observed region of attraction of fluxoids. In addition results on the penetration depths are summarized. (auth)

38300 NEW HIGH-FIELD SUPERCONDUCTOR, $V_2HF_xZr_{1-x}$ Inoue, Kiyosh (National Research Inst. for Metals, Tokyo); Tachikawa, Kyoji; Iwasa, Y. Appl. Phys. Lett.; 18: 235-7(15 Mar 1971).

The C-15 type structure $V_2Hf_x\ Zr_{1-x}$ shows a high-resistive critical field exceeding 200 kOe at 4.2°K whenever $x > 0.3$. The highest transition temperature, 10.1°K, and critical field, 230 kOe, are achieved with the composition $V_2Hf_{0.5}Zr_{0.5}$. For this material the critical current density at 4.2°K and 130 kOe is as high as 1×10^5 A/cm^2, which should make it of interest for practical use at high fields. (auth)

38301 ULTRASONIC ATTENUATION MEASUREMENTS IN NORMAL AND SUPERCONDUCTING CADMIUM. Peck, D. R.; Dobbs, E. R. (Univ. of Lancaster, Eng.). Phys. Lett.; 35A: No. 3, 196-7(31 May 1971).

Measurements of the anisotropy of the electronic attenuation, electron mean free path, and superconducting energy gap in cadmium are presented for the propagation of longitudinal ultrasound along the three principal crystallographic directions. (auth)

38302 SYNTHESIS OF Nb_3Sn BY SHOCK WAVES. Otto, G. (Marshall Space Flight Center, Huntsville, Ala.); Reece, O. Y.; Roy, U. Appl. Phys. Lett.; 18: No. 10, 418-20(15 May 1971).

The energy of a converging shock wave was used to form the intermetallic compound Nb_3Sn from its elemental powders. A reaction pattern indicative of compound formation is observed when a critical shock pressure is exceeded. The compound is obtained in a "pressure-temperature quenched state" and exhibits a transition temperature to superconductivity of 16.3°K. (auth)

38303 CRITICAL MAGNETIC FIELD OF THIN SUPERCONDUCTING FILMS. Litovchenko, V. A. (Patrice Lumumba Univ., Moscow). Phys. Status Solidi (b); 45: No. 1, 39-45(1 May 1971).

In recent papers on critical magnetic field of superconducting films, the one-electron state is treated almost in a "semiclassical" way, although the motion of electrons in the direction of the film thickness is described by a quantum number n, the special features of electron pairing in thin films were not taken into account. Thus, the results are valid only for thick metal films ($L \geqq 10^{-5}$ cm). In this paper, the quantization of electron motion in the direction of the film thickness is taken into account. This motion is described by a wave function $\psi(z)$ and a quantum number n. Moreover, Cooper pairs are built in a correct way. H_c is calculated for thin metal films. In the limiting case of thick films, the result agrees with that of Shapoval. Furthermore, the approach used permits study of semimetal and semiconducting films also, where H_c is calculated for the whole range of thicknesses (50 to 1000 Å). All results are valid near T_c. (auth)

38304 SUPERCONDUCTIVITY IN SIMPLE METALS. Rajput, J. S. (Banaras Hindu Univ., India). Phys. Status Solidi (b); 45: No. 1, 287-92(1 May 1971).

The superconducting state parameters for both nonsuperconductors and simple-metal (nontransition-metal) superconductors are evaluated using the exact OPW (orthogonalized-plane-wave) form factors based on the model pseudopotential of Heine and Abarenkov. An attempt is made to establish a criterion for the occurrence of superconductivity in nontransition metals using the pseudopotential approach, and it is inferred that more-reliable values of the superconducting state parameters can be obtained using a correct pseudopotential and the phonon spectrum. (auth)

38305 NEGATIVE SELF-INDUCTANCE IN SUPERCONDUCTING THIN WIRES AND WEAK LINKS. Christiansen, P. V.; Hansen, E. B.; Sjoestroem, C. J. (Univ. of Copenhagen). J. Low Temp. Phys.; 4: No. 4, 349-89(Apr 1971).

One of the most promising implications of the phenomenological Ginzburg-Landau (GL) theory of superconductivity is the possible existence of current-carrying metastable states with a negative effective self inductance. Microscopically this phenomenon can be explained as a result of the depairing mechanism which, when the center-of-mass velocity v_s of the Cooper pairs is sufficiently large, can be so strong that a further increase of v_s will lead to a decrease of the total current. Using a one-dimensional formulation of the GL theory the thermodynamic stability of these states is investigated for different external constraints, and the result is obtained that a negative self-inductance can only be stable if the length of the system in the direction of the current is smaller than a critical value comparable to the GL coherence length λ/κ. It is an experimental fact that states of negative self inductance are realized in Josephson junctions and other types of superconducting weak links because the dc supercurrent can be a decreasing function of the phase variable ϕ. The thermodynamic stability theory can therefore explain why weak links have to be short, and it also provides a unifying point of view by treating the phase ϕ and the current as a pair of thermodynamically conjugate variables for arbitrary one-dimensional systems. An important point is the operational phase definition as a thermodynamic parameter that can be controlled by the experimentalist. This requirement is essential for the general validity of the ac Josephson equation and it implies that ϕ must depend on the magnetic self inductance of the system. By applying the GL theory to weak links, the validity of the usual dc Josephson equation $I \propto \sin\phi$ is delimited, and it is seen that deviations from this functional form are most likely to be found in thin-film bridges of the Anderson-Dayem (AD) type. When the current I is the controlled variable, the conjugate phase variable ϕ will fluctuate, and the magnitude of these fluctuations depends strongly on the functional form $I(\phi)$. The phase fluctuations for constant I lead to a reduction of the critical current, which will be absent when ϕ is the controlled variable. The observed microwave enhancement of the critical current in AD bridges, the so-called Dayem effect, can be explained as a result of a switch from current control to phase control, and the fluctuation formulas explain why the effect is negligible in structures exhibiting the classical Josephson sine law for the current-phase relation. (auth)

38306 EFFECT OF TRANSPORT CURRENT ON THE DISTRIBUTION OF INDUCTION IN A TYPE II SUPERCONDUCTING CYLINDER. Ternovskii, F. F. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1790-1803(May 1971). (In Russian).

Conditions are formulated under which a persistent current may circulate in a closed superconducting circuit containing a section in the mixed state. The Gibbs free energy is found; it possesses a minimum for fixed current in the sample. The free energy density is calculated and induction distribution determined on the assumption that, in a long cylinder located in a longitudinal magnetic field and carrying a transport current, the vortex lines are helical lines with a constant pitch. The magnitude of the critical current is estimated. (auth)

38307 FIELD DEPENDENCE OF THE CRITICAL CURRENT IN AN ALLOY WITH A DISPERSIVE SUPERCONDUCTING PHASE. Pan, V. M. (Inst. of Metal Physics, Kiev). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1757-8(May 1971). (In Russian).

It is shown that in a superconductor in which dispersive superconducting phase particles (Nb_3Al) are so arranged in a normal matrix that they form a multiple connected system of current lines, the field dependence of the critical current is a power function and large values of the critical current density are attained (up to 3.5×10^5 A/cm^2). (auth)

38308 EXPERIMENTAL STUDY OF LIMITED FLUX JUMPS IN DIRTY TYPE-II SUPERCONDUCTORS: MAGNETIC INDUCTION DISTRIBUTION BEFORE AND AFTER A FLUX JUMP. Noel, J. L.; Mailfert, A.; Fournet, G. (Univ., Paris). J. Phys. (Paris); 32: No. 2-3, 191-204(Feb-Mar 1971). (In French).

Magnetic instabilities (flux jumps) were studied experimentally in a solid cylinder made of a dirty Type-II superconductor. The critical current density was assumed to be a function j(B,T) of the magnetic induction B and of the temperature T, and a theoretical

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calculation was made of the electrical field at each point of the superconducting cylinder when it is subjected to a slowly increasing external magnetic field parallel to the axis of the cylinder. It was found that the equations obtained make it possible to obtain from the experimental electrical field values the magnetic induction distribution in the superconductor after a flux jump, as well as the critical current density. The experiments were carried out on a cylinder of Nb–40% Ti immersed in liquid helium ($2\ K \leq T_0 \leq 4.2\ K$) or in helium gas under weak pressure. The resultant distributions of magnetic induction following a flux jump proved the importance of the heat transfer between the superconductor and the bath. In addition, the experiments allowed the determination of the magnetic field value where the first flux jump H_{fj} occurs and the distribution of the maximum temperature reached at each point on the cylinder during a limited flux jump. The results obtained are compared with the various theories previously proposed. (France)

38309 CURRENT NOISE IN WEAK SUPERCONDUCTORS. Kirschman, R. K.; Mercereau, J. E. (California Inst. of Tech., Pasadena). Phys. Lett.; 35A: No. 3, 177-8(31 May 1971).

The line width of the oscillating potential produced by phase slip in weak superconductors is found to be consistent with a simple two-fluid model incorporating fluctuations in the supercurrent stimulated by Johnson noise in the normal current. (auth)

38310 DEPRESSION OF EXCESS HALL CURRENT DUE TO ELECTRIC FIELD ABOVE T_c. Koyanagi, M. (Kyushu Univ., Fukuoka); Tsuzuki, T. Phys. Lett.; 35A: No. 3, 147-8(31 May 1971).

The effect of static and alternating electric fields on the Hall current due to thermodynamic fluctuations of the superconducting order parameter is studied above the transition temperature T_c. (auth)

38311 IMPURITY-INDUCED $T_c = 0^0K$ SUPERCONDUCTIVITY. Kirschner, I.; Stark, A. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 30: No. 1, 33-7(1971).

An earlier result, representing the dependence of critical temperature of the superconducting transition on the concentration of dia- and paramagnetic impurities is applied to the case when T_c approaches absolute zero owing to impurities. The rate of spin flip scatterings for an electron at the Fermi surface was calculated, when either the scattering processes or the change in the Fermi surface topology have a dominant role. The expressions obtained were verified by a comparison with experimental data and by numerical estimation. (auth)

38312 SUPERCONDUCTING TRANSITION TEMPERATURES OF VAPOR-DEPOSITED NIOBIUM NITRIDE. Oya, Gin-ichiro; Onodera, Yutaka (Tohoku Univ., Sendai). J. Vac. Sci. Technol.; 7: S44-7(Nov-Dec 1970).

From 2nd International Vacuum Metallurgy Conference, Anaheim, Calif. See CONF-700640.

Thin films of the superconducting compound niobium nitride were deposited at atmospheric pressure on fused silica substrates by reaction of gaseous niobium pentachloride with ammonia and hydrogen gases in a fused silica apparatus. Suitable conditions for the preparation of NbN were found by calculating the free energies of reaction for several possible reactions involving niobium chlorides, ammonia, and hydrogen. Niobium nitride films could be formed at substrate temperature ranging from 900 to 1000°C. The deposition rate varied with the reaction conditions from 20 to 1500 Å/sec, and deposits ranged from smooth films of polycrystals in which the individual crystal faces were 20 μ in length. The x-ray diffraction data for the NbN films deposited at 1000°C revealed face-centered-cubic structure with cube edge of about 4.358 Å. Niobium nitride films prepared by this method had a wide range of resistivities, temperature coefficients of resistance, and superconducting transition temperatures depending on the deposition conditions. The maximum transition temperature obtained was 15.75°K for the films deposited at 900°C. (auth)

38313 FORMATION OF SUPERCONDUCTING Nb_3Al AND Nb_3Al–Ge FILMS. Isao, A.; Noguchi, T.; Uchida, Y.; Kono, A. (Ulvac Corp., Kanagawa, Japan). J. Vac. Sci. Technol.; 7: S57-62(Nov-Dec 1970).

From 2nd International Vacuum Metallurgy Conference, Anaheim, Calif. See CONF-700640.

The formation of Nb_3Al or Nb_3Al–Ge compounds on niobium substrates is described. The film formation was followed using optical-microscopy and x-ray-diffraction techniques. Electrical-resistance measurements at cryogenic temperatures were obtained to determine critical transition temperature for superconductivity. The films were prepared by three processes: (a) dipping the Nb substrate into an Al–Ge melt contained in a graphite crucible, holding for several seconds followed by a thermal diffusion treatment; (b) vacuum deposition of Al or Al–Ge on Nb followed by heat treatment similar to that in (a)— the advantage of vacuum deposition is better control of the film thickness of Al or Al–Ge; and (c) simultaneous deposition of Nb and Al on Nb substrates in vacuum. The deposition rate of Nb and Al was controlled at a 3:1 atomic ratio. Germanium was simultaneously deposited with Al. The Nb_3Al or $Nb_3(Al–Ge)$ films were formed at temperatures between 1350 and 1650°C for both the (a) and (b) processes with the critical superconductive transition temperature between 15 and 17.5°K. The films prepared by simultaneous deposition of Al and Ge show that the superconducting behavior depends on the diffusion heat treatment. A heat treatment at 1000°C for 30 min resulted in a Nb_3Al film having 3:1 atomic ratio. The critical superconducting temperature for the films produced by these processes was between 15 and 16°K without an ordering heat treatment. A lowering of the heat treatment (diffusion) temperature for the simultaneously deposited films resulted in a critical superconducting temperature that is in agreement with values reported by Neugebauer for superconducting Nb_3Sn. The lower heat treating temperatures of 1000 and 1200°C are expected to result in higher critical current densities. (auth)

38314 MICROWAVE-ENHANCED SUPERCONDUCTIVITY. Shepard, Kenneth Wayne. Stanford, Calif.; Stanford Univ. (1970). 78p. University Microfilms Order No. 71-12,990.

Thesis.

The microwave properties of superconducting aluminum thin films were studied. The films were scribed into narrow strips which displayed a dipole antenna-like resonance when irradiated with microwaves over a wide frequency range. A tunable mm-wave source, an electron cyclotron maser that provides several milliwatts of power over the frequency range 30 to 128 GHz was constructed. To measure the dipole response, a low-temperature germanium microwave bolometer, usable over a broad frequency range, was also constructed. The dc critical current of the thin films was in good accord with the value predicted by the BCS theory. The microwave response was measured by the effect of microwave radiation on the dc critical current. A microwave-induced increase of the dc critical current, in some respects similar to the Wyatt effect (Phys. Rev. Lett., 16: 1166(1966)), was observed. The frequency dependence of the microwave enhancement of critical current is suggestive of a relationship between the dipole resonance and the enhancement. A model is proposed. (Diss. Abstr. Int., B)

38315 INTERNAL ELECTRIC FIELDS IN METALS AND SUPERCONDUCTORS. Rieger, Thomas John. Santa Barbara, Calif.; Univ. of California (1970). 96p. University Microfilms Order No. 71-11,486.

Thesis.

The strain-induced electric field in a metal is calculated through the electron–phonon interaction. For a strain field associated with a longitudinal sound wave, an electric field is found that points along the direction of propagation of the sound wave and oscillates at the frequency of the sound. For a power of ~1 watt/cm^2 in the sound wave, the induced electric field is ~1 volt/meter at 60 Mc. For a gravitational strain, an electric field is found to be of magnitude $\sim 10^{-6}$ to 10^{-7} volts/meter and is directed upward, in agreement with the results of Dessler, et al. The electric field in each case also exists inside superconducting materials, since once the field is decoupled the electron–phonon interaction is essentially unchanged. This implies, of course, that other electron–phonon effects (e.g., resistivity) are unaffected by either the strain field or the induced electric field. The Hall electric field inside a superconductor not in the vortex state is calculated using the time dependent Ginzburg–Landau equations. The field exists only in the skin of the superconductor. Part of the electric field dies out in a London penetration depth and part dies out in a coherence length. The gradient of the electrochemical potential is zero, however, so there is no Hall voltage. For an applied magnetic field ~100 G the magnitude of the electric field is 10^{-3} to 10^{-4} volts/meter. (Diss. Abstr. Int., B)

38316 THEORY OF TRANSITION-ELEMENT SUPERCONDUCTORS. Williams, Paul B. East Lansing, Mich.; Michigan State Univ. (1970). 150p. University Microfilms Order No. 71-12,005.

Thesis.

A theoretical expression for electron–phonon coupling is derived and then used in an attempt to explain differences in superconducting transition temperatures for groups VB and VIB transition metals. The bare ionic potential, based upon the Herman–Skillman atomic structure calculations, is used to

determine unscreened coupling. Screening is then calculated using the Bardeen self-consistent-field method modified for exchange. The net result is an expression for the screened electron–phonon coupling, $g_{K\,K'}$, exhibiting a positive dependence upon the electronic density of states at the Fermi level. Such a dependence is due entirely to exchange and is thought to stem from the preference of conduction electrons to group between nearest neighbors in some resonant structure remnant of atomic "d" electrons. A suitable computer program is developed to determine the product of coupling times phonon density of states as a function of phonon frequency, $\alpha^2(\omega)F(\omega)$. The method first uses interatomic force constants to determine the phonon density of states, $F(\omega)$, via the Born–von Karman method. The expression for screened electron–phonon coupling is then incorporated to include umklapp as well as normal scattering processes. Finally, within the currently accepted theory of superconductivity, $\alpha^2(\omega)F(\omega)$ is used to determine an expression for the superconducting transition temperature of tantalum and tungsten. (Diss. Abstr. Int., B)

38317 SUPERCONDUCTIVITY OF LANTHANUM AND URANIUM. Kusakabe, Takashi (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 45: No. 1, 324-6(Jan 1971).

The effect of nonmagnetic impurities on the critical temperature of lanthanum and uranium was studied in order to obtain information on the superconductivity of these elements. It was found that the critical temperature is very sensitive to the presence of impurities, if the level of an f-band is above the Fermi surface and rather close to it. It is concluded that the presence of the f-band near the Fermi surface in La and U is the cause of the large pairing interaction. (M.H.R.)

38318 QUANTUM OSCILLATIONS IN SUPERCONDUCTORS. Azbel, M. Ya.; Dubovskii, L. B.; Mints, R. G. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1895-1912(May 1971). (In Russian).

Quantum oscillations of the gap, current density, and surface impedance in superconductors are studied. Peculiarities of magnetic field oscillations are elucidated, and the period and temperature dependence of the amplitude are found. It is proven that the dispersion law $\xi(p)$ and gap $\Delta(p)$ can be determined experimentally on the basis of the oscillation amplitude period and temperature dependence. Restrictions on the Maxwell equations at the metal–vacuum interface are discussed. The rule for determining the phase under quasi-classical quantization conditions is found in the general case. (auth)

38319 SUPERCONDUCTIVITY AND PHASE DIAGRAMS. Zackay, V. F. (Univ. of California, Berkeley); Merriam, M. F.; Ralls, K. M. Refract. Mater.; 6: 87-101(1970).

The first two sections of this chapter describe how the superconductive transition is a phase transition in the true thermodynamic sense and, also, how several superconducting properties are highly dependent upon either structure or composition, or both; further, it is shown that the superconducting transition temperature is readily measured. The third and final section is devoted to the theme that the property of superconductivity can be an imported tool in determination of phase diagrams, and examples from the literature (primarily for ceramic or refractory compounds) are given to illustrate this point. 39 references. (L.M.T.)

Equipment and Devices

Refer also to abstract 38814.

38320 CONSTRUCTION AND PROPERTIES OF WEAK-LINK DETECTORS USING SUPERCONDUCTING LAYER STRUCTURES. Consadori, F.; Fife, A. A.; Frindt, R. F.; Gygax, S. (Simon Fraser Univ., Burnaby, B. C.). Appl. Phys. Lett.; 18: 233-5 (15 Mar 1971).

A new technique for the construction of weak-link loop devices (SQUID) is presented, which uses single crystals of $NbSe_2$, a superconducting layer structure. The devices display excellent stability against mechanical shock and thermal cycling to cryogenic temperatures. A comparison is made with existing point-contact devices. (auth)

38321 HEAT EXCHANGE IN LIQUID HELIUM BY PHONON TUNNELING THROUGH VERY THIN PLATES. Haug, H.; Weiss, K.; Van Hove, M. (Philips Research Labs., Eindhoven, Netherlands). J. Low Temp. Phys.; 4: No. 3, 263-71(Mar 1971).

Thin plates with a thickness d smaller than the phonon mean-free path can be used to increase the heat exchange in ^3He–^4He refrigerators at very low temperatures. The resistance R for the heat current density of these plates is theoretically investigated. For plates with d still larger than the dominant thermal-phonon wavelength λ_T in the plate, R is given by twice the Kapitza resistance. For $d \approx \lambda_T$, the resistance R decreases due to phonon tunneling. For $d \ll \lambda_T$, there exists a region where R varies as T^{-1}, in contrast to the T^{-3} dependence for thicker plates. Numerical calculations are carried out for copper plates immersed in pure ^4He. The results show that one obtains a large increase of the heat exchange due to phonon tunneling for plates with a thickness of a few microns at temperatures in the millidegree range. (auth)

38322 VARIATION WITH MICROWAVE POWER OF THE CURRENT STEPS OF SUPERCONDUCTING MICROBRIDGES. Gregers-Hansen, P. E.; Levinsen, M. T.; Pedersen, L.; Sjoestroem, C. J. (Univ. of Copenhagen). Solid State Commun.; 9: No. 10, 661-4(15 May 1971).

Observations of periodic variation with power of the current steps in the I–V characteristics of small superconducting bridge constrictions (Anderson–Dayem bridges) in a microwave field are reported. The results are compared with the predictions of the dynamical equations for a Josephson junction; agreement is found near the transition temperature. (auth) (UK)

Plasma and Thermonuclear Physics

38323 (NP-18901) PLASMA PHYSICS AND CONTROLLED THERMONUCLEAR REACTIONS, 1968–1969. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). 1970. 226p. (In Russian). Dep. NTIS (U. S. Sales Only).

The report contains 66 individual papers on plasma physics and fusion experiments carried out during 1968 and 1969 at the Institute. Studies on the interaction of high-frequency electromagnetic fields with magnetized plasma, high-intensity electron and ion beams, and pulse discharges predominate among the subjects of the papers. Several investigations were made to attenuate the magnetohydrodynamic and kinetic instabilities of the plasma by means of high-frequency fields and to heat up the plasma without collisions. In this connection, the mechanism of interaction of large-amplitude alternating fields with the plasma in the skin-layer region was examined; the results revealed that, under the prevailing experimental conditions in toroidal systems, the depth of the skin layer exceeded the classical value by several fold; because of the abnormally high ion temperatures, the level of the ion-acoustic turbulence was not high. This could mean that turbulent processes in the skin layer will not lead to an uncontrolled energy dissipation of the high-frequency fields in the plasma. Study of the behavior of the plasma in traps with longitudinal high-frequency currents revealed the existence of a strong low-frequency oscillation of the plasma pinch. Several papers were devoted to the study of toroidal systems operated with a rotational transformation of the lines of force. Papers on plasma diagnostics are also included in the collection. (TTT)

Confinement and Heating

Refer also to abstracts 38412, 38446, and 38522.

38324 (CONF-710607-2) PLASMA INJECTION, HEATING, CONFINEMENT, AND LOSSES IN MULTIPOLE STRUCTURES. Kerst, D. W.; Forsen, H. K.; Meade, D. M.; Lencioni, D.; de la Fuente, H.; Breun, R.; Cavallo, A.; Drake, J.; Jernigan, T.; Molvik, A.; Prater, R. (Wisconsin Univ., Madison). 17 Jun 1971. 13p. (CN-28/A-1). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Plasma behavior and losses to the walls and to the surfaces of the isolated levitated hoops in a toroidal octupole were examined for gun-injected and for microwave-produced plasmas with densities of 10^9 to 10^{11} cm^{-3} in the volume of 8×10^6 cm^3. Methods of plasma focusing by a magnetic lens, which increase the gun plasma-stream density by a factor of 40, are being applied to the octupole to raise the density. It was discovered that ECRH also generates hot ions in the levitated octupole. The energy and density of these ions is comparable to that of gun-injected plasma (10 eV to 200 eV). Thin striped multi-electrode plasma collectors measure losses to surfaces with minimal mechanical or electrical disturbance to the body of the plasma, and a modulated light beam was used to transmit signals outward from an isolated hoop. Losses to the hoop are sensitive to the time variation of B. A three-dimensional search of plasma structure with thin probes revealed some fluctuations during plasma motion caused by B more noticeable in the larger levitated octupole than in a small one-third-scale

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supported-hoop octupole. Correction of porthole field disturbances in the small octupole were successful in reducing losses by 30% in the vicinity of the hole. Injection inside the confinement region of the small octupole was used with small plasma sources to produce densities of 10^{13} cm^{-3}. These studies have shown that stability and trapping efficiency are dependent on the location and orientation of the injector, but not on the density. A toroidal magnetic field of 1000 gauss is being added to the levitated octupole. (auth)

38325 (CONF-710607-3) PLASMA CONFINEMENT IN THE DC OCTOPOLE. Ohkawa, Tihiro; Yoshikawa, Masaji; Gilleland, John R.; Tamano, Teruo (Gulf General Atomic Co., San Diego, Calif.). 17 Jun 1971. Contract AT(04-3)-167. 15p. (CN-28/A-2). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The plasma in the dc octopole decays in two successive stages: the collisional regime and then the collisionless regime. In the collisional regime the density decays in inverse proportion to the time from the density of 10^{11} cm^{-3} to about 2×10^{9} cm^{-3}. The measured diffusion coefficient varies linearly with the density and as −2 power of the octopole field. The values of the coefficient are within a factor of three of the theoretical values for the classical diffusion. In the collisionless regime the density decays exponentially. The confinement time is 0.4 sec for the hydrogen plasma with the electron temperature of 0.5 eV. The plasma losses to the supports and to the walls are comparable. The confinement time is affected by the following parameters: (1) impurity gas pressure, (2) ion mass M_i, (3) electron temperature T_e, (4) field errors, and (5) voltages applied to the particle loss collectors. The confinement time is shortened by the presence of the oxygen-containing gas such as O_2, H_2O, and CO_2 above the pressure of 10^{-8} torr. At the normal background pressure of these gases (below 2×10^{-9} torr) the effect is negligible. The confinement time scales as $\sqrt{M_i/T_e}$; T_e is increased by the electron cyclotron heating, and M_i is varied from hydrogen to neon mass. The confinement time is independent of the magnetic field strength. An error field applied externally shortens the confinement time. The scaling law of the confinement time is the same with and without the external error field. The single particle confinement experiment using filament-produced electrons also shows the similar scaling. These observations indicate that the plasma reaches the walls by flowing along the magnetic flux lines. A large voltage on the particle collector reduces the confinement time. The confinement time becomes dependent on the magnetic field suggesting a cross-field loss. In summary, the plasma loss at high densities is due to the collisional diffusion. In the collisionless regime, there are two loss processes, namely a trivial loss to the supports and a loss to the walls due to the field errors in the magnetic field. (auth)

38326 (CONF-710607-4) CONFINEMENT OF PLASMAS IN THE SPHERATOR. Freeman, R.; Okabayashi, M.; Pacher, G.; Ripin, B.; Schmidt, J.; Sinnis, J.; Yoshikawa, S. (Princeton Univ., N. J. Plasma Physics Lab.). 17 Jun 1971. 31p. (CN-28/A-3). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A spherator with levitated superconducting ring (LSP) went into operation in 1970. The ring has a current of 85 kA and can be levitated for periods up to two hours by means of magnetic feedback stabilization. Plasmas were formed by application of electron cyclotron resonance microwave power of up to 1 kW. Gases used were H_2, D_2, He, and Ar with filling pressures 1×10^{-6} to 2×10^{-5}. The electron temperature decays from 10 eV to 0.2 eV in the afterglow, due to atomic processes. Plasma confinement times of 100 to 200 msec were obtained under the best conditions in the density range 10^{10} to 10^{11}/cm^3. The observed confinement times are approximately 1/2 to 1/4 of classical confinement times calculated numerically, which indicates that an additional loss mechanism may still persist. This additional loss may be due to field errors or residual-plasma-density inhomogeneities in the form of fluctuations and convective cells. The insertion of a 0.1-mm diameter wire in the mirror region (to eliminate any high-energy electrons within several hundred μsec) still gave plasma confinement times of more than 100 msec, indicating that ionization by runaway electrons, if any, does not affect the confinement measurement significantly in normal afterglows. The good plasma confinement can be spoiled by the application of magnetic field perturbations of several percent of the confining field strength. It was also found that the plasma confinement times are very sensitively dependent on impurity concentration (chiefly H_2O). A partial pressure of 10^{-6} torr (gage reading) of impurity is sufficient to shorten the confinement time to approximately 10 msec. Plasma can also be ohmically heated by electric fields in the poloidal direction. The resulting plasma is almost fully ionized, with a plasma density of 2 to 5×10^{12}/cm^3. The electron temperature reaches 20 to 70 eV. The plasma density decay time (without correction for ionization) measured immediately after the ohmic heating pulse is approximately 20 msec. This plasma density decay time is short compared to the classical plasma confinement time of ~200 msec. (auth)

38327 (CONF-710607-5) PLASMA CONFINEMENT AND HEATING IN THE INTERNAL RING DEVICE F IV. Lehnert, B.; Bergstroem, J.; Bures, M.; Tennfors, E.; Wilner, B. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). 17 Jun 1971. 25p. (CN-28/A-4). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A closed magnetic confinement region of nearly spherical shape is produced in the device F IV by a ring-shaped internal conductor and a pair of external coils. The internal ring is suspended by magnetically guarded supports. To secure a good confinement, theory predicts that the guiding-center drifts of the plasma particles across the magnetic field must be small compared to the thermal velocity and that the separation distance of a pair of supports should be small compared to the support length. In the F IV device, a fully ionized plasma of density 2×10^{21} m^{-3} is created by means of crossed electric and magnetic fields. The plasma is surrounded by a neutral gas blanket. The azimuthal fluid motions are limited in the fully ionized state, and the plasma is sustained by high-frequency heating, tuned to the magneto-acoustical resonance frequency at about 1.1 MHz. The power absorption by the plasma is then of the order of 0.5 MW. In part of the experiments the supports were magnetized by a current up to 20 kA, at a mean strength of 0.3 Wb/m^2 of the main magnetic field. The experiments have indicated that magnetic line-tying effects at the outer plasma boundary are essential to the stability of the plasma, that plasma equilibrium becomes possible also in presence of magnetized supports, and that magnetic guarding of the latter reduces the total power losses of the plasma. (auth)

38328 (CONF-710607-6) PLASMA CONFINEMENT IN THE JAERI HEXAPOLE WITH HIGH TOROIDAL FIELD. Tamura, S.; Yamato, H.; Nagashima, T.; Yoshikawa, M.; Ohtsuka, H.; Sugawara, T.; Shiina, T.; Matsuda, S.; Mori, S. (Japan Atomic Energy Research Inst., Tokai). 17 Jun 1971. 12p. (CN-28/A-5). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Behavior of a plasma confined in a toroidal hexapole configuration (JFT-1) is studied with and without superposition of a toroidal magnetic field (B_θ). The quasi-stationary hexapole field is produced by three current-carrying hoops held in place by supports. The average hexapole field strength on the stability limit line is up to 2800 G, which corresponds to an average of 8 gyroradii between the separatrix and the stability limit line for 20-eV hydrogen ions. Plasmas, produced either by microwave heating at the electron cyclotron frequency ($kT_i < kT_e \sim 1$ eV, $n \sim 3 \times 10^{10}$ cm^{-3}) or by a coaxial gun ($kT_e < kT_i \sim 20$ eV, $n \sim 10^{11}$ cm^{-3}), are stably confined in the hexapole without noticeable fluctuations in the interior of the plasma. The measurement of particle loss shows that most of the plasma is lost across the magnetic field to the hoops and walls for microwave-produced plasmas. The particle lifetime is typically 1.2 msec and is consistent with the result of particle-loss measurements. The lifetime of the gun-injected plasma at higher magnetic fields is limited by the particle loss to the supports. At lower magnetic fields the lifetime agrees with the virtual confinement time calculated from the perpendicular loss rate. It approaches the support loss time as the magnetic field is increased. This feature is also consistent with the observed diffusion coefficients. (auth)

38329 (CONF-710607-7) CONVECTIVE MOTION IN THE CLIMAX TOROIDAL QUADRUPOLE DEVICE. Dellis, A. N.; Megaw, J. H. P. C.; Prentice, R.; King, C. D. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 15p. (CN-28/A-6). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Plasma confinement in the CLIMAX induced-current toroidal quadrupole was measured during a period of slow field decay giving ~15 ms of experimental time. Hydrogen plasma, peak density $n \sim 10^{12}$ cm^{-3}, $T_i \sim 50$ eV, and $T_e \sim 5$ eV fills the MHD-stable region inside the minimum $U \equiv \oint dl/B$ critical surface, ψ_c, in about 100 μs after cross-field injection from a 40-kV conical theta pinch with solenoid guide field. At the maximum ring current used (400 kA total) there are >5 ion gyro radii be-

tween ψ_c and the separatrix, ψ_s, and the calculated Bohm time for T_e = 5 eV is ~220 μs. The measured potential distribution shows a convective flow of plasma at ~10^5 to 10^6 cm/s around the major azimuth, ϕ, which reverses sign on crossing the separatrix ψ_s. Superimposed on this is a flow across the constant-U flux surfaces, as shown by azimuthal variations in the potential, which produces large-scale convective cells. The major cause of this flow is localized plasma cooling by neutral gas entering from the plasma gun. Charge neutrality in the presence of ∇B drifts requires that $\partial(nT)/\partial\phi = 0$ at all times, where $T \equiv T_e + T_i$, and T_i is the mean local ion temperature. A steady-state variation of potential V is produced and satisfies

$$\frac{\partial V}{\partial \phi} = -\frac{\partial V}{\partial \psi}\left[\frac{1}{T}\frac{\partial T}{\partial \phi}\right]\Big/\left[\frac{1}{nU}\frac{\partial (nU)}{\partial \psi}\right].$$

The local outward flux of plasma $\Delta\Gamma = nU(\partial V/\partial\phi)\Delta\phi$ is positive when $\partial T/\partial\phi$ is negative. The original plasma gun, producing >10^{-4} torr locally, gave density decay times ~2 ms, independent of B. A modified gun producing much lower neutral gas pressure inside ψ_c increased this time to ~4 ms with ~B^1 dependence. Where probe current measurements previously showed a similar decay rate, both inside and outside ψ_s, the plasma from the modified gun exhibits a decay time for $(nT_i^{3/2})$ which is slower inside ψ_s and exceeds 10 ms near the rings, with T_e > 3 eV. Simultaneous injection of neutral gas from a replica of the original gun causes the faster decay to reappear and probe measurements near it show a modification of the plasma flow agreeing with the theoretical model. Calculation of the total outward plasma flux $\Gamma = \int_0^{2\pi} nU(\partial V/\partial\phi)d\phi$ from the measured values of n and V shows, however, that the convective motion cannot by itself account for the observed plasma loss rate, but is rather a mechanism by which plasma is redistributed inside the trap. (auth)

38330 (CONF-710607–8) HIGH ENERGY GUN-INJECTED TOROIDAL QUADRUPOLE. Hammel, J. E.; Henins, I.; Kewish, R. W. Jr.; Marshall, J.; Sherwood, A. R. (Los Alamos Scientific Lab., N. Mex.). 17 Jun 1971. 5p. (CN–28/A–7). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A quadrupole device is being used to investigate the trapping and containment of an energetic gun plasma. The quadrupole is designed to contain a peak density of 5×10^{13} cm^{-3} at 2.5 keV within the MHD-stable region. At design field there are 5 gyro radii for 2.5-keV deuterons from the separatrix to the Ψ_{crit}. The interior conductors are directly driven with a 0.8-MJ capacitor bank. The current to the coils is fed through a single pair of dipole guarded conductors to each coil. The coils are also supported from the current feed. The dipole guard is in a force-free configuration with 5 gyro radii for 2.5-keV deuterons from the separatrix (between the dipole and quadrupole fields) to the dipole surface. The dipole is designed so that loss of plasma from the dipole region will be directed away from the interior conductors. This feature is necessary for the prevention of contamination by secondary gas produced by plasma lost at the dipole guard. Experiments at one-half design value of magnetic field have shown that the kilovolt-energy gun plasma is trapped by depolarization currents around the coils and that a very high percentage (>50%) of the gun output can be trapped. The plasma density is measured by a unique Michelson interferometer using CO_2 laser light. The energy of the plasma is derived from magnetic pickup loops placed outside the containment region. The leak caused by the dipole guard field was examined by double electric probe measurements. The plasma drift thus inferred is an order of magnitude less than that predicted by a model of Meade or by the author's calculations. This casts doubt upon the validity of any such simple model and emphasizes the necessity of further experimental investigation of the matter. New coils being built to operate at full-design magnetic field strength will allow a check on the containment time of the device for kilovolt-energy plasma. (auth)

38331 (CONF-710607–11) THEORETICAL STUDY OF E-LAYER AND PLASMA BEHAVIOR IN ASTRON. Anderson, D. V.; Benford, G. A.; Brettschneider, M.; Killeen, J.; Newcomb, W. A.; Mirin, A. A.; Rensink, M. E. (California Univ., Livermore. Lawrence Radiation Lab.). 29 Apr 1971. 30p. (CN–28/A–10; UCRL–72881). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The injection, equilibrium, and stability of the E layer and confined plasma in Astron are investigated. Self-consistent equilibrium configurations for a collisionless E layer and an ideal plasma fluid were obtained from a numerical solution of Ampere's law, using various models for both the E layer and plasma pressure profiles. The degree of field reversal and the shape of the magnetic well can be varied so as to obtain equilibria with favorable stability properties. The stability of an E layer, alone or in conjunction with a cold background plasma, was analyzed for modes with wavelengths less than or comparable to E layer dimensions. The results are in good qualitative agreement with experimental observations on the precession, negative-mass, and plasma hybrid modes. The most important stabilizing mechanism is seen to be energy spread in the E layer. The stability of the confined plasma is investigated using the MHD energy principle. A numerical solution of the eigenvalue problem, which arises from minimization of the potential energy, allows one to test the MHD stability of any of the equilibrium models used. The limiting plasma pressure is determined, and specific numerical examples of stable equilibria are given. A time-dependent numerical model of the Astron was also developed with which injection and trapping can be studied in detail. The effects due to the resistors, neutralization, and the ambient plasma were included. The model is axially symmetric. The E layer electrons are simulated by many thousands of finite-size super particles that move in the r–z domain and have velocity components V_r, V_ϕ, V_z. The model is relativistic and the electromagnetic fields are obtained by solving four wave equations—three for the vector potential and one for the scalar potential. The E layer and plasma currents and the current induced in the resistor wires are included in the above field equations. The computed self-fields are added to the external field to give the field configuration as a function of time. Numerical results indicate that resistive trapping behavior of one pulse is similar to that experimentally observed. Results of multiple pulse injection are presented. (auth)

38332 (CONF-710607–13) PLASMA HEATING AND STABILITY IN A COMBINED PINCH. Kvartskhava, I. F.; Zukakishvili, G. G.; Matveev, Yu. V.; Gvaladze, Yu. S.; Razmadze, N. A.; Besshaposhnikov, A. A.; Tikhanov, E. K.; Chkuaseli, Z. D.; Khautiev, E. Yu.; Butov, I. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). 17 Jun 1971. 22p. (In Russian). (CN–28/B–1). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Results of experiments with a discharge chamber of small diameter (d = 6.5 cm) with no filaments in the plasma are considered. The length of the theta-pinch magnetic coil L = 21 cm. The axial magnetic field $H_z \simeq 65$ kOe. The longitudinal current of the z pinch varied within the range 5 to 50 kA. The half-period of the discharge was the same for both pinches (T/2 = 9.5 μs); the two discharges were triggered simultaneously in an already existing plasma with electron temperature ~5 eV. The measurements showed that for currents not exceeding the Kruskal–Shafranov value (~10 kA) a plasma is stable throughout the half-period of the discharge; the electron temperature (determined by measuring the absorption of soft x rays by aluminum foils) rises with increasing H_z and reaches 150 eV when H_z is at its maximum. Neutron emission is also greatest at maximum H_z. Investigation of the axial and radial distributions of the neutron yield showed that neutrons are emitted from a plasma column with diameter ~1.5 cm and length ~15 cm, which coincides with the region of soft-x-ray emission. The total neutron yield is of the order of 10^6 per discharge and corresponds to an ion temperature ~1 keV. The electron concentration gradients along the radius of the plasma column and the electron concentration profiles were determined by means of the laser schlieren method with time resolution. In the absence of a filament-like structure, when the currents exceed the Kruskal–Shafranov value, a magnetohydrodynamic instability of the m = 1 mode with wavelength λ = 2L develops. The variations in the instability growth rate as a function of the current I_z agree qualitatively with MHD theory; however, the measured values are approximately an order of magnitude less than theoretical. Some data are also presented on the influence of a high-frequency (~0.7 Mc) longitudinal current on the stability of a combined pinch. (auth)

38333 (CONF-710607–14) Z-PINCH EXPERIMENTS WITH SHOCK HEATING. Baker, D. A.; Burkhardt, L. C.; DiMarco, J. N.; Forman, P. R.; Haberstich, A.; Karr, H. J.; Mann, L. W.; Phillips, J. A.; Schofield, A. E. (Los Alamos Scientific Lab., N. Mex.). 17 Jun 1971. Contract W-7405-eng-36. 13p. (CN–28/B–2; LA-DC–12206). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Two z-pinch experiments are described. In these experiments, a shock produces plasma temperatures higher than have been produced by ohmic heating. Theory predicts that with the higher temperatures the drift instabilities can be avoided, resulting in a reduction of the anomalous field diffusion. MHD calculations predict stable configurations for some diffuse z-pinch profiles with

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a reversed B_z field external to the pinch and a conducting wall. The linear z-pinch experiment has a length of 30 cm and diameter of 10 cm and the discharge current is ~200 kA. Initial $\dot{B}_\theta$'s of 80 kG/μsec produce the shock. A magnetic energy storage system generates the necessary high voltage (≲80 kV). Probes measure the initial shock structure and plasma pressure profiles. Together with holographic interferometric density measurements, they yield temperatures ($T_i + T_e$) of 750 eV and peak densities of $10^{16}/cm^3$ with initial pressure of 30 mtorr of deuterium. The limit of sensitivity of the holographic technique prevents data from being obtained at a lower filling pressure where higher plasma temperatures should be obtained. The plasma column exhibits gross stability for times of the order of the time scale of the experiment (~8 μsec). One-dimensional MHD calculations are performed both with classical and anomalous resistivities. The results, including density and magnetic field profiles, are compared with experiment. The toroidal experiment has a major diameter of 76 cm and a minor diameter of 10.25 cm. A 500-kJ inductive energy storage system develops a peak voltage of ≲320 kV around the circumference of the torus, with maximum plasma currents of about 200 kA. Iron cores couple the primary to the plasma secondary circuit. Toroidal equilibrium calculations were made for diffuse plasma profiles. A numerical stability analysis of these toroidal equilibria, free from previous limitations on aspect ratio, plasma and magnetic field profiles, and beta, is in progress. The toroidal z pinch has the advantage of having azimuthal symmetry, stable equilibria, and the possibility of exceeding the Kruskal–Shafranov limit. (auth)

38334 (CONF-710607-27) RADIAL TRANSPORT IN TOKAMAK DISCHARGES. Duechs, D. F.; Furth, H. P.; Rutherford, P. H. (Princeton Univ., N. J. Plasma Physics Lab.). 17 Jun 1971. Contract AT(30-1)-1238. 29p. (CN-28/C-4). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A multifluid numerical code is used to follow the evolution of radial profiles in the tokamak discharge. Particle diffusion, electron and ion thermal diffusion, energy equilibration, and field diffusion are included in the model. The transport coefficients appropriate to the banana, plateau, and hydrodynamic regimes of classical theory for an axisymmetric torus (neoclassical theory) are employed, with recently calculated numerical coefficients exact to lowest order in aspect ratio. Two basic cases are reported: (1) a simplified three-regime neoclassical code, neglecting particle transport; and (2) a banana-regime code that includes particle transport and modification of the particle and electron thermal fluxes by the trapped-particle pinch effect. Pseudoclassical transport was also studied, and various rules are examined for suppression of MHD-unstable skin-current layers. The relation of these results to present-day tokamak experiments is discussed, and neoclassical and pseudoclassical extrapolations are made to higher-temperature regimes. The code contains provision for the inclusion of high-Z impurities and cold and hot neutral atoms: these elements promise to be important to the simulation of present-day tokamak experiments. (auth)

38335 (CONF-710607-28) EFFECT OF AN ELECTRIC FIELD ON TRANSFER PROCESSES IN AXIALLY SYMMETRIC MAGNETIC TRAPS. Kovrizhnykh, L. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 17 Jun 1971. 21p. (In Russian). (CN-28/C-5). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

By solving the kinetic equation in the drift approximation, expressions are derived for the particle flux and energy density across a strong magnetic field in axially symmetric systems of the Levitron- or Tokamak-type. In addition to the longitudinal accelerating electric field, which is responsible for creating the longitudinal current, account is taken of the presence of a quasistatic electric field directed along the minor radius and resulting from ambipolarity of dispersion. Both the case of very low collision frequencies (lower than the characteristic frequency of the azimuthal motion of the "blocked" particles) and that of intermediate and high collision frequencies are considered. It is shown that, if either the thermal velocity of the particles or the ratio of the poloidal magnetic field to the longitudinal magnetic field is fairly large (so that the mean longitudinal velocity of the toroidally "blocked" particles is much less than the azimuthal variations of their longitudinal velocity), then allowance for the radial electric field corresponds to allowance in the flux expressions for corrections of the next higher (i.e. fourth) order with respect to the smallness parameter used. In the opposite limiting case, allowance for the radial electric field becomes very important: in the regions of very low and very high collision frequencies it leads to a substantial change in the functional dependence of the dispersion and heat-conduction coefficients on the plasma and magnetic field parameters, while in the region of intermediate collision frequencies it leads to corrections proportional to the square of the ratio of the Larmor radius in the poloidal magnetic field to the characteristic dimension of the plasma inhomogeneity. The question of determining a self-consistent radial electric field within the framework of a theory that takes into account only the lowest order with respect to the Larmor radius is discussed. (auth)

38336 (CONF-710607-29) IMPORTANCE OF THE TRAPPED PARTICLE PINCH EFFECT IN TOKAMAK PLASMAS. Ware, A. A. (Texas Univ., Austin). 17 Jun 1971. 22p. (CN-28/C-6). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A recent discovery has shown that, in a Tokamak plasma, the conservation of canonical angular momentum requires that all trapped particles drift towards the magnetic axis with velocity $-cE_\phi/B_\theta$, which is a factor B_θ^2/B_ϕ^2 greater than the usual $\underline{E} \times \underline{B}/B^2$ drift. (θ and ϕ are the angular coordinates in the poloidal and toroidal directions, respectively.) The importance of this drift has already been demonstrated in explaining both the good containment in stable Tokamaks and the relaxation oscillations that occur for low q or high density. Here, the effect is considered further in relation to the contraction and heating of the plasmas in the Tokamaks T-3 and ST, use being made of the new transport equations of Rosenbluth et al. The pulse length in these experiments is too short for a steady state to be attained, and four different phases are distinguished in the heating and compression of the plasma. In particular, it is shown that when β_θ is of the order unity, the dominant heating process is compressional heating caused by the trapped-particle pinch effect. An approximate calculation that balances ion thermal conduction with the compressional heating is shown to agree well with the final temperature profile in ST. The plasma in T-3 undergoes less contraction and compressional heating, the prime reason being that the driving force for the compression, the toroidal electric field, is maintained at sufficient strength for compression for a relatively shorter time. The new equations predict a more-rapid current penetration, and a case is made that electrostatic trapping will be important in making this penetration even more rapid. (auth)

38337 (CONF-710607-31) INVESTIGATIONS OF PLASMA CONFINEMENT AND HEATING IN THE TOKAMAK T-4 DEVICE. Artsimovich, L. A.; Vershkov, V. A.; Gorbunov, E. P.; Zaveryaev, V. S.; Ivanov, D. P.; Lysenko, S. E.; Mirnov, S. V.; Petrov, M. P.; Semenov, I. B.; Strelkov, V. S. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 8p. (In Russian). (CN-28/C-8). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Experimental studies of plasma column equilibrium, plasma energy balance, and ion heating are described. Since the main results are obtained with relatively high plasma concentrations ($n_e \geq 3 \times 10^{13}$ cm^{-3}), it is assumed that the transfer of energy from the electrons to the ions is due principally to Coulomb pair collisions. On the basis of this assumption, the ion energy lifetime τ_{E_i} is determined from the steady-state ion temperature and the known concentration of the plasma. The ion temperature is determined from the spectrum of the charge-exchange atoms, the intensity of neutron emission, and Doppler broadening of the hydrogen and deuterium spectral lines. Calculation of the total plasma energy is based on the diamagnetic effect. The experimental values obtained are compared with values calculated on the basis of extrapolation functions and with the results of calculations performed on the basis of the Galeev–Sagdeev theory. (auth)

38338 (CONF-710607-32) PARTICLE AND ENERGY BALANCE IN THE ST TOKAMAK. Dimock, D.; Eckhartt, D.; Eubank, H.; Hinnov, E.; Johnson, L. C.; Meservey, E.; Tolnas, E.; Grove, D. J. (Princeton Univ., N. J. Plasma Physics Lab.). 17 Jun 1971. 14p. (CN-28/C-9). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Plasma energy content and particle and energy confinement times were measured in the ST tokamak device. Initial filling pressure is varied from 3×10^{-5} to 3×10^{-4} torr in hydrogen or helium, ohmic heating current I_ϕ from 2 to 60 kA, and limiter diameter from 8 to 28 cm. Electron temperatures T_e and densities n_e at the center of the plasma range from 30 to 1500 eV and from 5×10^{12} to 1×10^{14} cm^{-3}, respectively. Particle confinement times range from 1 to 20 msec and are equal to corresponding energy confinement times to within a factor of two.

Radial profiles of electron temperature and density are measured by Thomson scattering of a ruby laser pulse. For typical plasma conditions, T_e is 800 to 1200 eV at the center. Late in the discharge the T_e profiles are much more strongly peaked than those reported for T3-A, although the total plasma energy content for comparable values of I_ϕ is approximately the same. Proton temperatures in hydrogen plasmas, measured by charge-exchanged neutrals, reach peak values of 400 to 500 eV. Ion temperatures, obtained from Doppler broadening of O VII (λ 1623) and C IV (λ 1548) lines, are in good agreement with proton temperatures. The measured plasma resistance is not significantly different from that calculated from the Spitzer formula using the measured content of impurity ions (primarily oxygen) and assuming that the electric field $\bar{E}_\phi$ is independent of minor radius. Plasma confinement improves rapidly with increasing I_ϕ. Over a range of two orders of magnitude the plasma energy content varies approximately as I_ϕ^3; at constant I_ϕ there is a weaker increase with n_e for the conditions studied. In comparison with available T3-A results, one finds substantial agreement on directly observable data, with the exception of radial temperature and density profiles, but there are significant differences in interpretation. The results do not indicate substantial anomalies in resistivity or in electron energy loss distinct from anomalous loss of particles. (auth)

38339 (CONF-710607–33) EFFECT OF NONAXISYMMETRIC CONFINING FIELDS ON TOKAMAK DISCHARGES. Stodiek, W.; Bol, K.; Eubank, H.; von Goeler, S.; Grove, D. J. (Princeton Univ., N. J. Plasma Physics Lab.). 17 Jun 1971. 20p. (CN–28/C-10). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

To test the importance of axisymmetry on confinement, the Princeton ST tokamak facility can provide a local toroidal field inhomogeneity up to ±30%, approximately equal to the radial variation of the toroidal field strength across the aperture. Discharge characteristics of the "symmetric" and asymmetric cases, respectively, were compared ($\Delta B/B$ = 1.5% and +30%) with the following results: a decrease in energy confinement time of 30% is observed for the asymmetric case, resulting from larger power input due to increased plasma resistivity, and to a lesser extent from a reduction of the amount of stored energy. The confinement time always remains longer than that obtained from C stellarator data, assuming Bohm scaling. The plasma resistance increase and the depletion of the energetic tail of the ion distribution, observed for the asymmetric case, are discussed on the basis of single-particle trapping. (auth)

38340 (CONF-710607–34) THEORY OF PLASMA CONFINEMENT IN A TOKAMAK AT HIGH TEMPERATURES. Galeev, A. A.; Sagdeev, R. Z. (Akademiya Nauk SSSR, Moscow. Institut Vysokikh Temperatur). 17 Jun 1971. 21p. (In Russian). (CN–28/C-11). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The dynamics of the plasma in a Tokamak are examined in cases where the path lengths are so long that the particles can justifiably be divided into "blocked" and "in-transit" categories. The paper consists of two parts, in the first of which the kinetic equilibrium of the plasma in a Tokamak is considered. In the determination of the equilibrium configuration of the magnetic field, account is taken of the "banana" currents of blocked and in-transit particles, which are similar to the Larmor current in a homogeneous magnetic field. Expressions are derived for the values of the diamagnetic signal and the displacement of the column measured during Tokamak experiments. The dynamics of the plasma column are calculated on the basis of equations for the heat balance and particles with neoclassical transfer coefficients. A value is found for the limiting pressure of the plasma in a Tokamak $\beta < (a/R)\ {}^3/_2 q^{-2}$ ($\beta = 8\pi p/B_0^2$, where p is the plasma pressure, B_0 is the toroidal magnetic field, and q the factor of assurance calculated at the boundary of the plasma column). The limiting pressure is determined from the Kruskal–Shafranov condition for the supplementary current occurring during entrainment of in-transit particles by blocked particles drifting through them. The second part of the paper analyzes the remaining difference between the neoclassical and experimental values of the transfer coefficients in dilute plasma. Models of the anomalous transfer due to low-frequency turbulence of the in-transit and blocked particles are discussed. (auth)

38341 (CONF-710607–49) ADVANCES IN RESEARCH ON TURBULENT HEATING OF A PLASMA. Zavoiskii, E. K.; Demidov, B. A.; Kalinin, Yu. G.; Plakhov, A. G.; Rudakov, L. I.; Rusanov, V. D.; Skoryupin, V. A.; Smolkin, G. E.; Titov, A. V.; Fanchenko, S. D.; Shapkin, V. V.; Sholin, G. V. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 44p. (In Russian). (CN–28/E-1). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

New experimental data are presented on turbulent heating and on the magnetic confinement of turbulently heated plasma. The physical state of the plasma was investigated under conditions of turbulent heating by a current, shock waves, and an electron beam. In the NPR-2 device, the change with time was studied of an epithermal ultra-high-frequency radiation spectrum, and the Stark profiles of the optical spectral lines were analyzed. The results confirm the ion-acoustic mechanism of anomalous resistance of the plasma. The strong anisotropy of the turbulent ion-acoustic oscillations is demonstrated. The energy distribution of the ions during turbulent heating of the plasma by the direct discharge current was measured in the TN-5 device. In the "Vikhr-2" toroidal trap the relationship was investigated between the anomalous resistance of the plasma and the mass of the ions. In the T-2M toroidal trap an investigation was carried out of turbulent heating by a current pulse, the direction of which coincides with that of the quasi-stationary current. Anomalous resistance occurs when $u/c_s \geq 8$ and is caused by ion-acoustic excitement. New data on the confinement of turbulently heated plasma were obtained with the "Vikhr-3" toroidal device. On the basis of the Stark broadening of the spectral lines of hydrogen and helium in UV-2, it was established that, upon the passage of a shock wave, intense electric oscillations are caused at ion-acoustic and lower frequencies. A method of electron-optical analysis of the Stark profiles of the spectral lines was also applied in an experiment on the interaction of an electron beam with the plasma in the PN-2 device, which showed that an electron beam caused intense Langmuir oscillations in the plasma. (auth)

38342 (CONF-710607–50) NEW RESULTS IN TURBULENT HEATING. Wharton, C.; Korn, P.; Prono, D.; Robertson, S.; Auer, P.; Dum, C. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 17 Jun 1971. 19p. (CN–28/E-2). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Rapid turbulent heating of a hydrogen plasma of $n_e \approx 10^{14}/cm^3$ was studied in a magnetic mirror by the application of a 200 kV pulse, causing a large current to flow along the magnetic field. When the initial plasma conductivity is ≤10 mho/m, the onset of turbulence (due to drift-excited two stream instability) occurs at a current threshold predictable by theory. When the conductivity is ≥50 mho/m, the skin effect retards current penetration, and the onset of turbulence is delayed, leading to inferior heating. As turbulence develops, the resistivity becomes anomalously large, hard x rays are emitted, and ions are heated in directions both parallel and perpendicular to B_z by ion acoustic waves excited as T_e/T_i becomes large enough. Turbulence decays rapidly and the resistivity drops at a certain nkT where the instability is quenched by a decrease in T_e/T_i. Energy densities of $\approx 10^{11}$ eV/cm^3 are achieved in <0.5 μsec, followed by stable confinement with a decay time constant $\tau \sim 150$ μsec. The ion energy distribution determined by energy analysis of charge-exchange neutrals is nearly isotropic, but has two temperature components: 90% of nkT pertains to ~400 eV, 10% to ~2 keV. Theoretical arguments are given to support the preferential heating of the tail in the ion distribution. The heated plasma is flute-stable, and the loss rate is dominated by Coulomb scattering of ions into the loss-cone. The spectrum of turbulence was measured by microwave scattering. The major frequency components during the heating phase are the electron plasma frequency, the ion plasma frequency, the ion cyclotron frequency, and lower frequencies following the dispersion of ion acoustic waves. Turbulent wave energies correspond to $\tilde{n}/n \approx 10\%$. Ion acoustic waves of this level can account for the anomalous resistivity as measured by rf conductivity probes. Although ion cyclotron waves of large amplitude are seen during early stages of the heating pulse, it can be shown that these waves have little effect on ν_{eff} or on the plasma heating. (auth)

38343 (CONF-710607–51) EXPERIMENTS ON PLASMA HEATING BY THE DISSIPATION OF CURRENT DRIVEN TURBULENCE. Hamberger, S. M.; Jancarik, J.; Sharp, L. E.; Aldcroft, D. A.; Wetherell, A. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 13p. (CN–28/E-3). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

For the proper exploitation of turbulent heating in fusion experiments, it is necessary to know both the scaling laws for the effective plasma conductivity and the way in which both species of plasma particles are irreversibly heated by collisionless dissipation of the fluctuations. To this end, experiments were conducted on TWIST (a small toroidal stellarator with R = 32 cm, r = 5 cm,

XUM

B_ϕ = 3 kgauss, i = 120°, l = 3) in which turbulence is generated by applying axial electric fields up to 500 V cm^{-1} in pulses <1 μs duration to plasma of density 10^{11} to 10^{13} cm^{-3} having various ion masses. It was found that the nature of the dependence of the conductivity σ on the experimental parameters changes with the type of microfluctuation spectrum present, which is studied using both electric probes and electromagnetic wave scattering. To study the electron heating, both the x-ray spectrum emitted from an immersed solid target and the bremsstrahlung at a wavelength (λ = 2 mm) at which no nonthermal emission can be detected were measured. The former cannot distinguish between true thermal and collective electron motion and gives the time variation of total electron energy, while the latter measures the true temperature. One finds that the electrons very rapidly acquire high energy in the fluctuating fields and thermalize to a true temperature ~10 keV as the turbulence decays. The time-dependent velocity distribution of the ions is measured from the flux of charge-exchange neutrals ejected radially from the magnetic trap corrected for the time-of-flight between the plasma and the final detector. The spectrum of the broad-band, nonthermal microwave emission associated with the turbulence is measured using a 10-channel multiplex receiver covering the band 8 to 40 GHz. (auth)

38344 (CONF-710607-52) TURBULENT RESISTIVITY, DIFFUSION, AND HEATING. Fried, Burton D.; Kennel, Charles F.; MacKenzie, Kenneth; Coroniti, Ferdinand V.; Kindel, Joseph M.; Stenzel, R.; Taylor, Robert J.; White, Roscoe; Wong, Alfred Y. (California Univ., Los Angeles); Bernstein, William; Sellen, J. M. Jr. (TRW Systems, Redondo Beach, Calif.); Forslund, David (Los Alamos Scientific Lab., N. Mex.); Sagdeev, R. Z. (Akademiya Nauk SSSR, Moscow. Institut Vysokikh Temperatur). 17 Jun 1971. 8p. (CN-28/E-4). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Current flow with density $j > N_e C_s$ ($c_s \equiv \sqrt{T_e/m_i}$ = ion acoustic velocity) should encounter resistance due to ion acoustic turbulence when $T_e \gg T_i$. This was observed in experiments with a streaming cesium plasma (B = 0), in which electron current, potential rise due to turbulent resistivity, spectrum of unstable ion acoustic waves, and associated electron heating were all measured directly. Kinetic theory calculations for an expanding, unstable plasma, give results in agreement with experiment. The effective electron collision frequency is of order 5 to 10 ω_{pi}. In a strong magnetic field, with $T_e/T_i \sim 1$ and current densities less than $N_e a_e$ ($a_e = \sqrt{2T_e/m_e}$), typical for present Tokomaks, the plasma is stable to ion acoustic but unstable to current-driven electrostatic ion cyclotron waves. Relevant characteristics of these waves are calculated and it is shown that, for ion $\beta > m_e/m_i$, the electromagnetic ion cyclotron wave has a lower instability threshold than the electrostatic one. However, when ion acoustic turbulence is present, ($T_e/T_i > 5$) experiments with Double Plasma (DP) devices show rapid anomalous heating of an ion beam streaming through a plasma. These DP devices also produce large-amplitude, collisionless ion acoustic shocks, both laminar and turbulent. At low Mach numbers, a beam of reflected ions is observed. Turbulence, either natural or triggered by fluctuations of injected ion waves, scatters the reflected ions and heats the shocked ions (observed broadening of distribution function). Shock structure is very sensitive to T_e/T_i and especially to the presence of light ions: a few percent He in an Ar plasma can significantly change both the shock amplitude and the laminar/turbulent transition. At higher density ratios (obtained with photoionization and microwave, upper hybrid, resonant heating) the Mach number increases (maximum observed ~1.8) and the structure washes out. (auth)

38345 (CONF-710607-53) TURBULENT HEATING OF A PLASMA COLUMN IN A LINEAR DISCHARGE. de Kluiver, H.; Piekaar, H. W.; Rutgers, W. R.; Schrijver, H.; de Groot, B. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). 17 Jun 1971. 9p. (CN-28/E-5). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The heating and subsequent expansion of a hydrogen plasma column by the application of supercritical fields is reported. A 15-mm diameter plasma column, length 0.6 m, is produced by a hollow-cathode discharge. Arc densities are varied between 10^{19} and 10^{20} m^{-3} with initial electron temperatures between a few and several tenths of electron volts. The arc plasma is guided by a magnetic mirror field with a mirror ratio of 2 and a peak induction of 0.4 T. The turbulent state is excited by discharging a capacitor of 1.8 μF at 15 to 40 kV across the length of the plasma column. A resistance in series with the arc provides a critically damped current wave whenever the plasma exhibits a classical resistivity. Turbulence can be ended at a preset time by means of a crowbar switch. When the electric field exceeds the Dreicer limit, turbulent states can persist during 2 μs. Initially, the arc column expands rapidly through the surrounding gas blanket up to the electrode diameter of 40 mm. The gas blanket is ionized and densities of 10^{20} m^{-3} are measured. During turbulence, the time dependence of the anomalous resistance is determined with a fast digitizing technique under widely different conditions of arc parameters and electric field strengths. Only during the turbulent state is hf radiation present and its spectrum is scanned up to 8 GHz. Considerable plasma heating is measured for electron cyclotron frequencies below the electron plasma frequencies. Energy densities of 5×10^{22} eV m^{-3} are obtained at plasma densities of 10^{20} m^{-3}. The ion energy distribution is measured at various electric field strengths and heating times. The major part of the ions can attain temperatures of 700 eV. The energy transfer at 0.2 T reaches a value of 4%. (auth)

38346 (CONF-710607-54) CONFINEMENT OF A DENSE TURBULENTLY HEATED PLASMA IN THE OGRA-2T DEVICE. Zhil'tsov, V. A.; Karkhov, A. N.; Likhtenshtein, V. Kh.; Panov, D. A. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 14p. (In Russian). (CN-28/E-6). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

It is shown that, when a discharge from a capacitor bank with an energy storage capacity of several kilojoules passes through a plasma with a density of 10^{12} to 10^{13} cm^{-3} in Ogra-2T, two heating stages are observed. The first stage is associated with the development of an ion-acoustic instability, the second with the generation of a beam of fast electrons and the development of a beam instability. The effective collision frequency during both heating stages is of the order 10^9 to 10^{10} s^{-1}. The maximum plasma energy is 6×10^{16} eV cm^{-3}. The fast ion component of the plasma is investigated in detail. Measurements with an electrostatic analyzer show that the ion spectrum occupies a wide energy interval which completely covers the operating range of the analyzer (0.5 to 120 keV). The mean ion energy obtained from these measurements is 3 to 10 keV. The mean energy of all the ions in the plasma is 2 to 3 keV. The energy of the fast ion component is equal in order of magnitude to the total plasma energy. The decay time constant of the fast ion component is in the range 40 to 100 μs. Measurements of the rate of decay of the ion component in various parts of the energy spectrum show that it remains virtually the same in the range 0.5 to 120 keV. (auth)

38347 (CONF-710607-55) NEUTRON MEASUREMENTS OF THE EFFICIENCY OF CURRENT TURBULENT HEATING OF IONS AND OF THE CONFINEMENT OF A HOT HIGH-DENSITY PLASMA IN A MAGNETIC MIRROR TRAP. Manzyuk, N. A.; Reva, N. I.; Suprunenko, V. A.; Sukhomlin, E. A.; Ternopol, A. M.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 17 Jun 1971. 21p. (In Russian). (CN-28/E-7). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The effect of the thermalization of various types of high-amplitude plasma waves induced in a current-carrying plasma was produced by the method of turbulent heating. In particular, it was shown that the effective heating of the electrons and ions of a high-density plasma can be effected in a high-current gas discharge in a homogeneous magnetic field ("Grom-3"). Under these conditions some 60% of the energy introduced into the discharge is expended on heating the plasma, and the maximum density of the kinetic energy in the plasma was of the order of 3×10^{18} eV/cm^3. The heating observed was brought about by the development in the discharge of an extensive series of successive current instabilities. In the experiments carried out in a homogeneous magnetic field, however, the hot plasma was seen to have a short lifetime owing to escape to the electrodes. An investigation was made of turbulent heating and the confinement of a dense plasma ($n = 10^{15}$ cm^{-3}) associated with a high-current gas discharge (I = 200 kA, T = 12 μs) in a magnetic field of the mirror type (H max = 50 kOe, H min = 25 kOe), the distance between the mirrors being 30 cm, and the working gas deuterium. The heating and confinement time of the plasma were determined on the basis of the full yield of neutrons per pulse ($N = 10^5$) measured with a Born counter and on the basis of the diamagnetic effect determined by a loop encompassing the discharge chamber (R = 5 cm). (auth)

38348 (CONF-710607-62) UNDERSTANDING TURBULENT ION HEATING IN THE OAK RIDGE MIRROR MACHINE, "BURNOUT V." Alexeff, I.; Berry, L. A.; Dudley, J. M.; Estabrook, K. G.; Hirose, A.; Jones, W. D.; Neidigh, R. V.; Olsen, J. N.; Scott, F. R.; Stirling, W. L.; Widner, M. M.; Wing, W. R. (Oak Ridge National Lab., Tenn.). 17 Jun 1971. 16p. (CN-28/E-14). Dep. NTIS.

From fourth conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Theoretical calculations have shown that a variety of crossed-field instabilities can heat ions effectively. Such instabilities are caused by (1) a radial density gradient (briefly suggested by Mikhailovskii and Tsypin for Ioffe's ion-heating experiment), or (2) a shear in azimuthal rotation, or (3) ion-electron collisions, or (4) the presence of two ion species. These modes have a frequency and growth rate $\approx\omega_{pi}$, and have a k with k||B much less than k ⊥ B. To study the heating process, the following were used: (1) a high-speed auto- and cross-correlator with an upper frequency limit of 25 GHz; (2) electric field-induced emission from the satellites of normally forbidden helium spectral lines — a technique that yields electric field intensity, polarization, and frequency; (3) soft x-ray counters that observe the spreading and deceleration of the electron beam into the mirror throats; (4) a charge-exchange analyzer that measures both the spatial and temporal behavior of the hot-ion plasma for ions in the energy range 0.5 to 20 keV, and for any desired mass; and (5) a D–D reaction rate monitor sensitive to either 3-MeV protons or 1-MeV tritons, and that determines their point of origin precisely. (auth)

38349 (CONF-710607–63) MECHANISM OF TURBULENT HEATING AND OF LOSSES IN TOKAMAK DEVICES. Rudakov, L. I. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 21p. (In Russian). (CN–28/E–15). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

On the basis of the theory of anomalous resistance developed in the work of the author and of L. V. Korablev, an explanation is given of the experimental results obtained in the work of K. A. Razumova and G. A. Bobrovskii. Anomalous resistance may be caused in a strong magnetic field by the instability of short-wave, $kr_{He} \gg 1$, ion Langmuir oscillations. The laws of turbulent heating of ions are examined. It is shown that the characteristic time for losses of the hot component of the ions is determined by "classical" diffusion in toroidal systems due to scattering on the fluctuations of the electric field, which result in an anomalous plasma resistance and heating of the electrons and ions. When there is anomalous conductivity under the conditions of the experiments, development of a superheating instability in an even-more-pronounced form than in the case of Coulomb conductivity is possible. As a result of this, the main part of the current should flow through thin high-conductivity filaments submerged in a plasma with a lower temperature and a higher resistance and thermal conductivity. It is then possible to reconcile the experimental value for the energy lifetime with the expression derived from the theory of Galeev and Sagdeev, taking into account the real value of the effective frequency of electron scattering. (auth)

38350 (CONF-710607–64) TURBULENCE IN CONFINED PLASMAS AT HIGH ELECTRIC FIELDS. Bers, A.; Coppi, B.; Dupree, T. (Massachusetts Inst. of Tech., Cambridge); Kulsrud, R. (Princeton Univ., N. J.); Santini, F. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). 17 Jun 1971. 23p. (CN–28/E–16). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Magnetically confined plasmas carrying a relatively large current in the direction of the main magnetic field are considered in regimes where the applied electric field is larger than the runaway critical field. The plasma is assumed to be turbulent with a relatively low fluctuation level induced by ion sound waves, Langmuir waves, and ion cyclotron waves. Three aspects of the problem are examined: (a) transfer of momentum within the electron distribution from superthermal velocities to thermal velocities, i.e., the inhibition by turbulence of the runaway process; (b) anomalous (larger than collisional) heating of the ion energy distribution tail; and (c) transfer of momentum from slow electrons to ions by ion-sound waves and classical collisions. (auth)

38351 (CONF-710607–66) THEORY OF TURBULENT HEATING AND ANOMALOUS DIFFUSION IN PINCH PLASMAS. Forslund, D.; Morse, R.; Nielson, C. (Los Alamos Scientific Lab., N. Mex.). 17 Jun 1971. Contract W-7405-eng-36. 16p. (CN–28/E–18; LA-DC-12216). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The large anomalous diffusion and resistivity seen in the compression of high-temperature-pinch plasmas and in collisionless shock waves is shown to be consistent with the nonlinear development of the electron cyclotron drift instability. Numerical simulations provide the basis for a detailed nonlinear or turbulence theory, and scaling rules for sheath thicknesses and heating rates are obtained. (auth)

38352 (CONF-710607–69) ENERGY BALANCE AND DYNAMICS OF PLASMA HEATING BY A BEAM OF ELECTRONS ACCELERATED IN A STRAIGHT HIGH-CURRENT DISCHARGE. Karchevskii, A. I.; Strakhov, Yu. I. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 34p. (In Russian). (CN–28/E–21). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Anomalous energy losses through the grid anode of a straight high-current discharge excited in a hydrogen plasma with an initial density of 10^{12} to (6×10^{13}) cm^{-3} and an initial electron temperature of several electron volts were studied in the Aspa device. The straight discharge is excited along a magnetic field of 1500 Oe by means of a 0.2-μF capacitor bank charged to 5 to 50 kV. The frequency of the straight discharge circuit is 640 kc. It is shown that, depending on the initial plasma density and the applied electric field, there develops in the discharge an instability that manifests itself in anomalous plasma resistance and a subsequent interruption of the discharge current. Approximately 0.1 μs before the current is interrupted and throughout the interruption (~0.2 μs), there are generated in the straight discharge beams of accelerated electrons with an energy of the order of the voltage applied to the plasma and a current comparable with the total discharge current. The beams of accelerated particles are extracted through the grid anode into an equipotential space, filled beforehand with a cold plasma, and a study is made of the heating of the plasma through the collective interaction between the accelerated electrons and the plasma. Using the bolometric method, the energy entrained by the electrons through the anode of the straight discharge was measured, and it was shown that under certain conditions more than 50% of the energy stored in the capacitor bank used to produce the straight discharge is transferred to the beams of accelerated electrons. The interaction between the electron beam and the cold plasma leads to strong heating of the plasma up to a pressure $nT \approx 10^{16}$ eV cm^{-3}. The speed of propagation of the diamagnetic signal front along the plasma column was measured, obtaining a value of (1 to 7) × 10^9 cm/s. It is also shown that the total thermal energy transferred to the plasma is 5 to 40% of the energy of the beam of electrons passing through the anode of the straight discharge. (auth)

38353 (CONF-710607–70) DYNAMICS OF PLASMA HEATING IN COLLISIONLESS HIGH-AMPLITUDE SHOCK WAVES. Lominadze, D. G.; Pataraya, A. D. (Akademiya Nauk Gruzinskoi SSR, Tbilisi. Institut Fiziki). 17 Jun 1971. 14p. (In Russian). (CN–28/E–22). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The theory of the transition region to higher Mach numbers was studied. The transition region is characterized by the following physical pattern: the initial stage of the transition is caused by an anomalous resistance to the ion sound, after which in a plasma of this type with an electron distribution (which differs substantially from the Maxwellian) a subshock of an electrostatic nature is produced under the influence of ion-acoustic turbulence. A theory was constructed with respect to this subshock on the basis of the electron distribution function, $\sim Exp(-dV^5)$, which is established after the anomalous resistance to the ion sound. A critical Mach number, subnumber M*, is introduced which, as is shown by calculations, is $M^* = 3.5$. It is shown that when $M > M^*$ the subshock is inhibited and fast ions occur. The mechanism is examined of ion heating when $M > M^*$ and when the subshock is inhibited. (auth)

38354 (CONF-710607–71) IMPLICATION OF PSEUDO-CLASSICAL DIFFUSION FOR TOROIDAL CONFINEMENT DEVICES. Yoshikawa, S. (Princeton Univ., N. J. Plasma Physics Lab.); Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). 17 Jun 1971. 18p. (CN–28/F–1). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Upper limits on transport coefficients, due to fluctuations and convective cells, are derived using quasi-linear approximations and results are compared with experiment. Diffusion across the magnetic field is found to increase over classical diffusion by an enhancement factor $[1 + \langle k_\perp^2/k_\parallel^2 (\delta n/n)^2 \rangle]$, where $k_\parallel$ and $k_\perp$ are the averaged wave numbers parallel and perpendicular to the magnetic field, and δn is the amplitude of the fluctuation. The particle confinement time is determined essentially by the equivalent toroidal current flowing in the plasma. This may explain why the sphe-

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rator configuration has a good confinement even though the toroidal magnetic field strength is very small compared to a typical Tokamak. This argument would also predict that the Astron configuration would have good confinement provided the E-layer was sufficiently rigid. Two new Astron configurations with toroidal field are considered. One is essentially a spherator with the ring replaced by an E-layer, which also heats the plasma. The E-layer has the special properties, due to the toroidal field, that synchrotron radiation is greatly reduced and the ring current can greatly exceed the Lawson limit. In the other configuration, the combination of E-layer and toroidal field creates a toroidal minimum-B geometry with the advantages that trapped-particle instabilities are eliminated and the plasma poloidal beta is increased. (auth)

38355 (CONF-710607-73) ANOMALOUS CONTRIBUTION OF LOW-FREQUENCY, LONG-WAVELENGTH FLUCTUATIONS TO SPATIAL DIFFUSION OF A PLASMA IN A MAGNETIC FIELD. Ichimaru, Setsuo (Tokyo Univ. (Japan). Dept. of Physics); Rosenbluth, Marshall N. (Institute for Advanced Study, Princeton, N. J.). 17 Jun 1971. 12p. (CN-28/F-2).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Diffusion coefficient $D_\perp$ of the electrons across a magnetic field (with strength B) is calculated in terms of the spectral function of the electric-field fluctuations. For a Maxwellian plasma, one finds that an effective electron-ion collision frequency defined by $\nu \equiv \Omega_e^2(m_e/T_e)D_\perp$, where $\Omega_e = -eB/m_e c$ and T_e is the electron temperature in energy units, contains an anomalous term ν^* in addition to the usual classical term; the diffusion coefficient arising from ν^* is proportional to B^{-1}, when $k_D^2(T_e/m_e) \gg \Omega_e^2$, and to B^{-2} ln B when $k_D^2(T_e/m_e) \ll \Omega_e^2$, where k_D is the Debye wavenumber. The electron fluctuations in the low-frequency domain such that $\omega < |\Omega_e|$ give rise to the anomalous term. When such fluctuations are enhanced above a thermal level owing to the onset of an instability, the anomalous term will grow accordingly, resulting in an enhanced diffusion; a microscopic account of the Bohm diffusion is thereby obtained in terms of a theory of strong turbulence. The factor of enhancement of the low-frequency fluctuations necessary to produce a Bohm-diffusion rate is estimated numerically for a C-stellarator and for a Tokamak; the comparison may offer at least a partial account of the difference in containment times between the two cases. (auth)

38356 (CONF-710607-74) DEVELOPMENT OF AMBIPOLAR ELECTRIC FIELD AND FLOWS IN TOROIDAL PLASMAS. Stringer, T. E. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 12p. (CN-28/F-3). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The development of poloidal and toroidal flows in an axisymmetric collisional plasma, in a Tokamak-like magnetic field, is studied. A radial electric field builds up to equalize the ion and electron diffusion rates, leading to poloidal rotation. Earlier treatments of this buildup phase assumed the rate of change with time of all equilibrium quantities to be second order in the inverse-aspect-ratio expansion. Time rates of change terms are now included as correction terms in the first-order equations. Their inclusion reduces the predicted growth rate of poloidal rotation by a factor of order $(1 + 8\pi^2/\iota^2)^{-1}$. It is known that in the weak collisional regime the ambipolar state requires a diffusion-driven current parallel to the magnetic field, in addition to any externally driven currents. A general equation is derived relating the build-up of such a parallel current and mass flow to pressure anisotropy and temperature variation. In typical experimental conditions the ambipolar value of the diffusion-driven current is found to fall off inversely as the collision frequency over the intermediate collisional range and to maintain a value of order $(r^2/R^2B_\theta)(dp/dr)$ throughout the collision-dominated range. (auth)

38357 (CONF-710607-77) RADIATION LOSSES IN CERTAIN THERMONUCLEAR SYSTEMS. Galushkin, Yu. I.; Gervids, V. I.; Kogan, V. I. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 18p. (In Russian). (CN-28/F-6). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Numerical calculations are presented of radiation losses due to heavy impurity ions in two types of thermonuclear devices. Radiation losses in the Tokamak system are first discussed. The impurities are assumed to be carbon, oxygen, and other elements. The results of the calculations show that it is very important to allow for the effect of nonstationary conditions: the true power loss through radiation can, broadly speaking, exceed by an order of magnitude the steady-state value that has frequently been used in estimating radiation losses. Radiation losses in the plasma focus system are then discussed. Detailed numerical calculations are made of the level populations of the impurity ions and of the corresponding radiation losses from a hydrogen plasma for a wide range of electron temperatures and concentrations. Impurity ions with charge numbers in the range $5 \le Z \le 18$ are considered on the assumption that the plasma is stationary and optically thin, which corresponds to the conditions of a plasma focus. Ionization and excitation processes in a collision-radiation system are considered. For the high temperatures reached in a plasma focus it was possible to assume that the impurity ions were present in the plasma only in the form of bare nuclei and ions similar to beryllium, lithium, helium, and hydrogen. It is shown that the characteristic emission times of the plasma can be comparable with the focus lifetime and, consequently, that radiation can affect the focus parameters considerably. (auth)

38358 (CONF-710607-79) EXPERIMENTS IN THE TOKAMAK-6 DEVICE. Vinogradova, N. D.; Vlasenkov, V. S.; Gorbunov, E. P.; Leonov, V. M.; Mukhovatov, V. S.; Petrov, M. P.; Sinitsyna, L. D. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 12p. (In Russian). (CN-28/F-8). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Results are presented of initial experiments carried out in Tokamak-6. The device is a torus with a major radius of 70 cm. The plasma column is maintained in equilibrium with the help of a conducting casing and an external magnetic field at right angles to the surface of the torus. The conducting casing, made of vacuum-fused copper, is attached to ceramic insulators inside the vacuum chamber. The casing has four transverse joints and one joint in the equatorial plane. The radius of the casing cross section is 25 cm, and its wall thickness is 0.8 cm. A gold coating 10-μ thick was applied to the inner surface of the casing by spraying under vacuum. The diaphragm consists of three separate sections. The radius of the zone bounded by the diaphragm can be changed from 15 to 25 cm without disturbing the vacuum conditions in the system. The experiments were carried out with a longitudinal magnetic field intensity of up to 15 kOe. The electron density in the plasma column was measured with the help of a multichannel microwave interferometer. The thermal energy of the plasma was determined on the basis of the diamagnetic effect. For measurement of the ion temperature, spectral analysis of the neutral charge-exchange atoms was used. The relationship between the energy lifetime of the plasma and various parameters, including the radius of the diaphragm opening, is shown. The temperatures of "blocked" and in-transit ions are also compared. (auth)

38359 (CONF-710607-84) PLASMA CONFINEMENT IN A TOKAMAK WITH $\beta_l \gg 1$ AND ARBITRARY CURRENT DISTRIBUTION. Shafranov, V. D.; Yurchenko, E. I. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 11p. (In Russian). (CN-28/F-13). Dep. NTIS (U. S. Sales Only).

From fourth conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The problem of the equilibrium of a plasma column is solved by performing an expansion in powers of the parameter $\epsilon = \sqrt{a/R}$, it being assumed that $\beta_l \sim 1/\epsilon$. An equation is derived for determining the shape of the cross section of a plasma column with $\beta_l \gg 1$ for given boundary conditions. The shape of the transverse cross section of the plasma is related to the magnetic probe readings and to the index characterizing the manner in which the confining transverse magnetic field grows weaker when there is no casing. The criteria for the hydromagnetic stability of plasmas in Tokamak devices are also discussed. (auth)

38360 (CONF-710607-88) EXPERIMENTS ON CONFINEMENT OF A PLASMA IN A CIRCULAR MAGNETIC WELL, DECA II B. Launois, D.; Lecoustey, P.; Nicolas, M.; Tachon, J.; Kesner, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 17 Jun 1971. 10p. (In French). (CN-28/G-1). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The quadrupolar magnetic well used in the DECA experiment was modified to reduce the plasma-wall interaction. Two quadrupolar windings, situated on both sides of the well, focus the magnetic lines. The tube of flux contained in the chamber (diameter 40 cm) has a radius of 4 cm in the median plane. The magnetic configuration is static: $B_0 = 3.5$ kG, mirror ratio 1.84, transverse depth of well r = 1.05 to 20 cm. The inlet mirror of the configuration is cancelled by a pulsed field to permit injection

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of the plasma produced by an induction gun. After the transitory capture phase, in the case of the regime studied most intensively, the plasma has a density of 3×10^{11} cm^{-3} at the center of the well. The half-height width of the density profile is 6 cm. The mean ion energy is 500 to 700 eV, and the half-height width of the spectrum is 400 eV. For a base pressure of 2×10^{-7} torr, with no titanium evaporation on the walls, the time constant for density decrease (τ) is 400 μs; this value is maintained during the observation time of 3 ms. For a base pressure of 10^{-8} torr, with titanium evaporation on the walls, $\tau_1 = 400$ μs during the first 800 μs of confinement, after which the time constant increases to $\tau_2 = 1.5$ ms during the final phase of confinement (from t = 2.5 ms to t = 7 ms). The angular distribution of the ions $f(\vartheta)$, (with $\vartheta = \arctan(v_{||}/v_\perp)$, changes in the course of time. At the beginning of confinement $f(\vartheta)$ has a minimum for $\vartheta = 0$; at 600 μs, $f(\vartheta)$ is a maximum at $\vartheta = 0°$ and its half-height width is of the order of 20°. This width is then maintained throughout the evolution of the plasma. When $\partial f(\vartheta)/\partial\vartheta > 0$, there is a strong emission at ω_{ci} and at the harmonics. The time constant τ_1 of the measured density at the median plane could be explained by a spatial redistribution of the plasma due to hf turbulence and to the establishment of the ambipolar potential. The time constant τ_2 is probably determined mainly by charge exchange. The pressure measured at the wall increases from 10^{-8} torr to 3×10^{-7} torr in 1 ms and then slowly decreases. (auth)

38361 (CONF-710607–89) THE FORMATION OF PLASMA BY INJECTION AND DISSOCIATION OF ACCELERATED HYDROGEN "GRANIONS." Bottiglioni, F.; Coutant, J.; Fois, M.; Prevot, F. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 17 Jun 1971. 10p. (In French). (CN–28/G-2). Dep. NTIS (U. S. Sales Only).

From fourth conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The INGRA experiment is an experimental study of the formation of a hot-ion plasma ($T_i \simeq 1.5$ keV) by the injection, dissociation, and capture of a beam of accelerated hydrogen "granions" in a magnetic configuration. The granions are agglomerates of hydrogen atoms with one or more positive electric charges. The accelerator is described. The neutral agglomerates (granules) produced in a supersonic jet of hydrogen, previously cooled to the region of the liquefying temperature, are charged by electron bombardment and accelerated to 600 kV by an electrostatic potential difference. Mass analysis of the accelerated beam is carried out by means of a magnetic separator, which can be used for analyzing mass/charge numbers N/Z up to 10,000 at 600 keV. Using an 0.3 × 4 mm capillary nozzle, one can obtain, in the continuous regime, a beam of the order of 70 mA equivalent (4×10^{17} atoms/s), whose mass spectrum is very broad and has a maximum N/Z close to 100, corresponding at 600 keV to an energy of 6 keV/atom. A definite increase in the beam intensity can be obtained by increasing the pressure upstream of the expansion at the same time as the capillary temperature. There is also an increase in the granule size; the electron density in the ionizer must then be increased to bring the mean mass of the granions to the values of interest ($N/2 \simeq 100$ to 500). To take into account the reduced mean mass in the ionizer, a model is proposed that assumes that when an electron ionizes a granion that has already been singly charged, the granion dissociates spontaneously by electrostatic repulsion into two granions of complementary mass, each with a charge, in a process of the following type: $H_n^+ + e \rightarrow H_n^{++} + 2e \rightarrow H_{fn}^+ + H_{(1-f)n}^+ + 2e$ with $0 < f < 0.5$. With each value of f is associated a probability p(f). The calculations based on this model for different forms of p(f) with an ionization cross section proportional to $N^{\frac{1}{2}}$ are in good agreement with experimental results. (auth)

38362 (CONF-710607–90) CONTAINMENT OF A PULSE-HEATED PLASMA IN AN OCTOPOLAR MINIMUM-B CONFIGURATION. Jacquinot, J.; Leloup, C.; Poffe, J. P.; De Pretis, M.; Evrard, P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 17 Jun 1971. 12p. (In French). (CN–28/G-3). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Investigations are being performed on the containment of a plasma injected by a gun with no electrodes into a deep octopolar minimum-B configuration consisting of a magnetic mirror trap with a 1.9 length ratio and eight stabilizing rods; (well volume ≈ 35 l, magnetic field at center $B_z = 2000$ G). The trapping of the plasma is achieved by increasing its perpendicular energy through the action of a pulse of axial magnetic field B (pulse duration 1.7 μs). This pulsed field escapes from the containment field and two types of plasma are obtained, depending on whether or not inversion of the direction of the resultant field occurs. The first type of plasma ($\alpha = |B\sim|/|B_z| > 1$) comprises a population of hot electrons ($T_e = 15$ keV, $\tau_{1/e} = 9$ ms) and a population of hot ions of mean energy $\langle E \rangle = 2$ keV. The half-height width of the spectrum is equivalent to 1.6 keV, the pressure anisotropy ($\vartheta_i = \langle E_\perp \rangle / \langle E_{||} \rangle = 9$), and the density, which reaches its maximum at $\alpha = 1.2$, is approximately 10^{13} cm^{-3}. The second type of plasma ($\alpha < 1$) contains no hot electrons. Compared with the previous case, the ion energy is identical and the density is approximately one-third as much. This density is at a maximum with a mirror ratio perpendicular to the wall of $R_{\perp p} = 1.2$. The presence of the minimum-B configuration suppresses the plasma losses at the walls; in these conditions, without any special pumping, the ion containment times are 130 and 250 μs, respectively, for the two types of plasma. Oscillations were observed in the vicinity of the ω_{ci} harmonics, but it is the charge exchange which limits the containment time; in the light of the changes in the neutral gas pressure and in the shape of the ion distribution function, the charge exchange can be attributed to a mixing ($\frac{1}{3}$ H_0, $\frac{2}{3}$ H_2) produced by the plasma/wall contact during the heating pulse. A high-speed titanium pump unit is installed in the injection stage, in the magnetic well, and in the plasma jet expansion stage. The characteristics of the plasma obtained under these conditions, which are currently being recorded, are presented. (auth)

38363 (CONF-710607–92) USE OF A HOT-ELECTRON TARGET PLASMA FOR ACCUMULATION OF ENERGETIC IONS IN STABILIZED MAGNETIC MIRROR TRAPS. Ard, W. B.; Blanken, R. A.; Colchin, R. J.; Dunlap, J. L.; Guest, G. E.; Haste, G. R.; Hedrick, C. L.; Lazar, N. H.; Lyon, J. F.; Sigmar, D. J. (Oak Ridge National Lab., Tenn.). 17 Jun 1971. 16p. (CN–28/G-5). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Fast H^0 injection into a highly ionized, high-density target plasma is expected to be an effective technique for producing dense, steady-state, hot-ion plasmas ($\omega_{pi}^2 \gg \omega_{ci}^2$). In developing this technique for stabilized mirror traps, target plasmas were created in mirror-quadrupole geometry by microwave fields which heat electrons produced by ionization of ambient hydrogen gas while leaving the protons cold. Hot-ion accumulation by injection into these plasmas was examined. Experiments in the INTEREM device use 10-GHz resonant power (resonant with electrons at 3780 gauss) either alone or in combination with fields at 35 GHz (well above any electron gyrofrequency in the trap). In either case the target density can reach 1 to 2×10^{12} cm^{-3} ($\omega_{pe} \approx \omega_{ce}$), with the ambient neutral gas density a factor of approximately 50 lower. This factor does not appear to be a fundamental limitation, but rather is fixed by the base pressure presently attainable in the experimental device. When resonant power is used alone, high-frequency instabilities ($\omega \sim \omega_{ce}$) associated with the velocity-space anisotropy can be identified. These modes are suppressed by addition of the nonresonant power, which increases the relativistic electron population. Theoretical evaluations indicate this can be sufficient to suppress the modes seen. In this stable regime the average plasma pressure is $\beta > 0.4$ in a volume of ~1.5 liters. The results of hot-ion experiments are described in which ~50 mA of 1 to 2-keV H^0 are injected into these target plasmas. The objective (i.e., dominant hot-ion population) requires improved targets. To this end, a second facility (IMP) is presently being commissioned to extend these experiments to higher magnetic fields (12.5 kG for resonant heating at 35 GHz and $\omega_{pe} = \omega_{ce}$ at ~1 × 10^{13} cm^{-3}), lower ambient gas density, and a more energetic H^0 beam of higher current. Here targets of 10^{13} cm^{-3} density and $n_e/n_0 \gtrsim 300$ should be sufficient to permit rapid buildup of energetic ions into the 10^{12} cm^{-3} range with 1-ampere injected H^0. (auth)

38364 (CONF-710607–93) RECENT DEVELOPMENTS OF THE PLEIADE DEVICE. Geller, R.; Jacquot, B.; Jacquot, C. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 17 Jun 1971. 21p. (In French). (CN–28/G-6). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

In the accelerating structure (hf power 500 W) energetic electrons ($W_\perp^- > 1$ keV) are created by ECR (3000 MHz) in a static B gradient (B ~ 1000 G). In the VB, ions are accelerated by a space charge field due to the motion of the electrons ($W_{||}^+ \simeq W_\perp^- \simeq 1$ keV). The electron reflecting structure is constituted by a pulsed |B| mirror (T ~ 8 ms) creating a symmetrical space charge field for ion reflection. In this manner, energetic spiraling electrons and axially accelerated ions are accumulated. Accumulation ratios A ~ 1000 are obtained in the range of 10^{-6} torr by measuring the leaking fast neutrals on the axis with a digital counting system. The energetic ion lifetime $\langle T^+ \rangle$ and the accumulation ratio A vary with neutral pressure p in the magnetic bottle as 1/p. The results show also that stable accumulation is possible during the entire

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mirror pulse and that charge exchange is the limiting loss mechanism for the energetic ions. Ion lifetimes of several milliseconds with energetic particle densities $n \gtrsim 10^{10}$ were obtained. The measured diamagnetism is then $10^{12} < nkT < 4.10^{13}$ eV cm^{-3}, and the rise time of the diamagnetism is similar to the fast neutral rise time, indicating that the energetic electrons and ions are accumulated at the same rate in the magnetic bottle. Recently, in order to obtain a higher brightness in the accelerating structure, the frequency was increased to 10,000 MHz, hf power to 2.5 kW, and B to 3000 gauss. With the new device one could prove that the plasma beam intensity was increased by a factor 10 ($nv \sim 10^{17}$ ions $\cdot$ cm$^{-2} \cdot$ s^{-1}) with the same average energy ($\langle W^+ \rangle > \sim 1$ keV). $\langle W^+ \rangle$ was measured as previously by analyzing the fast neutrals issuing on the axis and by spectrometric measurements of the Doppler shift on H* particles resulting from charge exchange on the residual gas. ($P_0 < 10^{-5}$ torr.) The Doppler shift indicates that the ions are not monokinetic but exhibit a broad velocity spectrum. The peak value of the spectrum varies proportionally with microwave power in the range 0.5 to 2.3 kW. In order to transform these ions with an H^0 beam a new type of neutralization cell is under construction. (auth)

38365 (CONF-710607–94) INVESTIGATION OF PLASMA DECAY IN THE PR-6 ADIABATIC TRAP. Baiborodov, Yu. T.; Ioffe, M. S.; Kanaev, B. I.; Sobolev, R. I.; Yushmanov, E. E. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 24p. (In Russian). (CN–28/G-7). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The injection technique was modified by modernizing the plasma source and using a hf radial electric field for ion heating. The plasma investigated has the following parameters: $n_0 = (2 \text{ to } 3) \times 10^{12}$ cm^{-3}; $\overline{W}_i \simeq 0.5$ keV; and $T_e \simeq 30$ eV. The transverse dimension of the plasma through the central cross section of the trap is about 10 cm. Confinement of the plasma was studied by measuring the rate of free decay of the plasma after injection had ceased. Various characteristics of the decaying plasma and their time variations were studied: plasma density (measured by means of a radio interferometer); integral flux of charge exchange neutrals; differential fluxes of charge exchange neutrals in different energy ranges from 200 eV upwards; plasma potential; and ion and electron streams through the magnetic mirrors. A comparison of these characteristics indicates that the decay of a plasma with a high initial density proceeds in an anomalous manner. The decay process can be divided into three markedly different stages. The first stage lasts 120 to 150 μs. During this period the total plasma density falls to $1/3$ of its initial value. The decrease in density is due to the escape of the ions with the lowest energy, the confinement of which is weakened by an ambipolar field in the plasma. The second stage lasts 200 to 250 μs. By the end of it the plasma density has fallen to $1/20$ of its initial value. This stage is accompanied by bursts of high-frequency oscillations, which manifest themselves in strong fluctuations of the plasma potential, in an increase in the mean value of the plasma potential over time, and in an increase in the flux of fast charge-exchange neutrals (with energies of 200 eV or more). In the frequency range investigated (2 to 18 Mc), the oscillations constitute a uniform background without any marked increase in amplitude near the ion-cyclotron frequency Ω_i ($\Omega_i = 10$ Mc). When densities of (1 to 2) $\times 10^{11}$ cm^{-3} are reached, the background vanishes and the third, slow stage of decay begins. This has a characteristic time of $\sim 10^{-3}$ sec and exhibits no visible anomalies (charge exchange decay). The experimental results point to the occurrence of a hf instability during the second stage of decay. The nature of this instability has not yet been ascertained. (auth)

38366 (CONF-710607–96) A POSSIBLE METHOD OF OBTAINING A COLLISIONAL PLASMA IN A MAGNETIC MIRROR TRAP. Golovin, I. N.; Kartashev, K. B.; Pistunovich, V. I.; Platonov, V. V.; Ryutov, V. D.; Filimonova, E. A. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 21p. (In Russian). (CN–28/G-9). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Conditions for suppressing the high-frequency cone instability were studied. Methods were studied for producing a plasma with an ion distribution function that is as close as possible to equilibrium from the very outset. The possibility of trapping, in a magnetic mirror trap, a dense bunch of fast atoms injected perpendicular to the direction of the magnetic field over a period of 10 to 20 μs is discussed. Such a bunch of fast atoms results from the charge exchange of a plasmoid containing ions with a wide velocity spread in a gaseous magnesium target. The bunch of atoms is trapped as a result of charge exchange in a short-lived plasma target within the trap itself. The plasma-target is produced by injecting a plasmoid from the second plasma gun along the magnetic field lines. The trapping efficiency can exceed 50% for a plasma-target density of $\sim 10^{14}$ cm^{-3}. Experiments involving the charge exchange of a plasmoid with an energy of about 1 kJ in a magnesium target are described. It is shown that the fast ions constituting the bunch undergo effective charge exchange and are transformed into neutrals. The injection of a particle bunch, which has undergone charge exchange and which has a density of 10^{13} cm^{-3}, into the transverse magnetic field of a trap was investigated, the process in the light of the velocity of the particle bunch and the strength of the magnetic field was also examined. Régimes are obtained in which up to 10^{17} particles with an energy of several keV reach the center of the magnetic trap in a single pulse through a cross section of 10^2 cm^2. (auth)

38367 (CONF-710607–97) EXPERIMENTAL AND THEORETICAL INVESTIGATION OF PLASMA BUILD-UP AND MICROINSTABILITIES IN A NEUTRAL INJECTION MIRROR MACHINE. Thompson, E.; Cordey, J. G.; Sweetman, D. R. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 17p. (CN–28/G-10). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Plasma trapping and the onset of exponentiation on the contained hot plasma in a high-energy injection experiment are described. The value of the cross section for plasma trapping deduced from these measurements is 2.8×10^{-15} cm^2, whereas a theoretical estimate yields a value of 4.6×10^{-15} cm^2. Further investigations of the microinstability have shown that the threshold density for instability is determined by electron Landau damping. Both the scaling and absolute measurements of the thresholds are in very good agreement with theoretical calculations. The anomalous loss of hot ions due to the microinstability was measured and is characterized by a diffusion time of ~0.2 sec. Increasing the radial (and hence axial) magnetic well depth results in a 50% reduction of the loss rate. (auth)

38368 (CONF-710607–99) PLASMA CONTAINMENT IN THE LRL 2X EXPERIMENT. Coensgen, F. H.; Cummins, W. F.; Finlayson, V. A.; Nexsen, W. E. Jr.; Simonen, T. C. (California Univ., Livermore. Lawrence Radiation Lab.). 14 May 1971. 16p. (CN–28/G-12; UCRL–72882). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

An open-ended magnetic well system was filled with deuterium plasma through the use of programmed pulsed magnetic fields to trap and compress plasmas injected along a constant magnetic field. At the end of magnetic compression the density was 3 to 5×10^{13} electrons/cm^3, the mean ion energy 6 to 8 keV, and the electron temperature 100 to 200 eV. Containment of the deuterium plasma was extended by nearly a factor of two relative to previously obtainable values (to times greater than 2 msec) by improvements that reduced the late influx of impurities. The observed evolution of density and ion energy was compared with classical mirror losses predicted on the basis of coulomb collisions. These calculations were performed through the use of a two-dimensional code that solves the complete Fokker–Planck equations for ions, including electron cooling of ions and ambipolar potential. Anomalous loss rates at a plasma density of 3×10^{13} ions/cm^3 are about twice the rate arising from collisional effects. This experiment was rebuilt (2X II) in order to increase the magnetic well depth, mirror ratio, and ion temperature as well as to reduce wall effects, which limited the density and energy of the injected plasma in the previous device. Experiments are now in progress to determine loss rates as a function of mean ion energy and as a function of the breadth of the energy distribution. (auth)

38369 (CONF-710607–102) AN INVESTIGATION OF THE CONFINEMENT OF A DENSE PLASMA IN THE TOR-1 STELLARATOR. Akulina, D. K.; Andryukhina, E. D.; Nechaev, Yu. I.; Fedyanin, O. I.; Khol'nov, Yu. V. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 17 Jun 1971. 29p. (In Russian). (CN–28/H-2). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Confinement conditions are investigated as functions of the collision frequency, the rotational transform angle, and the intensity of the magnetic field. Use was made of the uhf method of creating and heating plasma, permitting a transition to substantially higher collision frequencies (dense plasma). When uhf heating was applied in the TOR-1 stellarator, a plasma having the following parameters was obtained: density $n_e = 3$ to 5×10^{12} cm^{-3}; $T_e = 3$ to 8 eV; density of neutrals $n_0 = 10^{13}$ cm^{-3}; the working gases were argon and helium. This permitted an investigation of a wide range of changes in the collision frequencies (Coulomb-type collision and collisions with neutrals) with a transition to the

region of hydrodynamics. An investigation was carried out of the relationship between the plasma lifetime and the rotational transform angle $0.1 \leq (\iota/2\pi) \leq 3$, the density of the magnetic field H = 1 to 10 kOe, the temperature of the electrons, and the density. The experimental results were compared with those obtained on the basis of classical diffusion theory. (auth)

38370 (CONF-710607-103) INVESTIGATION OF THE MINIMA IN THE PARTICLE CONFINEMENT TIME IN THE WENDELSTEIN IIa STELLARATOR. Grieger, G.; Ohlendorf, W.; Pacher, H. D.; Wobig, H.; Wolf, G. H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 17 Jun 1971. 9p. (CN-28/H-3). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

For not-too-large values of iota, previous experiments in contact-ionized barium plasmas have demonstrated confinement in accordance with classical theory, except in the neighborhood of the low-order rational values of iota. The minima in confinement there observed may be understood as the result of stationary or nonstationary convection. The experiments reported here were concerned with the investigation of these minima. In particular, measurements of the dependencies of the peak density on the input flux, magnetic field strength, and neutral pressure were carried out at various iota to test theoretically predicted relations. Low-frequency oscillation was observed, and the influence of shear on the position of the minima was investigated. The conclusion is drawn that the most probable explanation for the observed minima is an unstable transition between the classical diffusion and a stationary or nonstationary convection. (auth)

38371 (CONF-710607-104) EXPERIMENTAL INVESTIGATION OF QUASISTATIONARY LONGITUDINAL ION STREAMS IN THE L-1 STELLARATOR. Berezhetskii, M. S.; Grebenshchikov, S. E.; Kossyi, I. A.; Sbitnikova, I. S.; Shpigel, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 17 Jun 1971. 25p. (In Russian). (CN-28/H-4). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

With the help of a specially developed technique, the motion of the ion component in one direction along the axis of the toroidal chamber was recorded. The experimental results indicate an absence of either qualitative or quantitative agreement with the conclusions of the existing theory of plasma equilibrium in toroidal traps. In particular, the measured directed velocities considerably exceed the values predicted by the theory; the longitudinal stream detected in the experiment does not change its direction in the transverse cross section of the chamber; the radial dependence of the directed velocities and their dependence on the rotational transform angle of the magnetic field lines—relationships found in the experiment—contradict the theoretical relationships. To explain the observed effect, a hypothesis based on the existence of "blocked" particles in the toroidal trap was used. In the presence of radial electric fields, the longitudinal velocity distribution function of the particles becomes asymmetric, which leads to the appearance of an effective ion stream directed along the axis of the toroidal chamber. The relationships found in the experiment confirm the unique connection between the electric field and longitudinal ion stream values. Comparison of the experimental results with calculations performed on the basis of the suggested hypothesis confirms the validity of the explanation given of the mechanism whereby the ion stream occurs. (auth)

38372 (CONF-710607-105) CONFINEMENT OF A PLASMA IN A TWO-TURN STELLARATOR AT RESONANCE VALUES OF THE ROTATIONAL TRANSFORM ANGLE. Ivanovskii, M. A.; Popov, S. N.; Popryadukhin, A. P.; Rabinovich, M. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 17 Jun 1971. 29p. (In Russian). (CN-28/H-5). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

In the TOR-2 two-turn stellarator, a field of resonance harmonics with a relative magnitude of the order of 10^{-4} has a highly destructive effect on the magnetic surfaces. However, with the help of a special compensation system it was possible to take these harmonics to the 10^{-6} to 10^{-7} level and to obtain magnetic surfaces of a satisfactory shape. At the resonances $\frac{1}{2}$ and $\frac{3}{2}$, the magnetic islands were compensated by fields with one spatial harmonic: (q,p) = (1,2) and (3,2), respectively. However, at the resonances $(\iota/2\pi) = 1$ and 2, it proved necessary to use two types of compensating harmonic: (1,1) and (2,2) for the resonance $(\iota/2\pi) = 1$ and (2,1) and (4,2) for the resonance $(\iota/2\pi) = 2$, their amplitude and phase being selected in the appropriate manner. A detailed study is made of the influence of perturbation compensation on the lifetime, the oscillation type, and other confinement characteristics of a plasma in a stellarator. It is found that the dependence of plasma lifetime on the degree of compensation is complex, indicating the simultaneous influence of several of the factors noted above. However, the best magnetic field compensation does not destroy the plasma confinement time minima in the event of resonances, in spite of the fact that the density distribution over the cross section of the device becomes symmetric. Study of the density distribution, potential, and oscillation type shows that there is an increase in the transfer coefficients within the resonance surface. On the basis of the experimental data, an attempt is made to explain the observed phenomena within the framework of existing theoretical conceptions. (auth)

38373 (CONF-710607-106) PLASMA CONTAINMENT IN THE PROTO-CLEO STELLARATOR. Bolton, R. A. E.; Hugill, J.; Lees, D. J.; Millar, W.; Reynolds, P. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 14p. (CN-28/H-6). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Measurements are reported of the confinement of plasma in the Proto-Cleo l = 3 stellarator. The plasma was produced in this machine by a variety of methods, including the irradiation of a metallic target by a laser beam, and covers a density range from 10^9 to 10^{13} cm^{-3} and electron temperatures from 2 to 10 eV. With the rotational transform of up to 2π radians used in the experiment, the plasma conditions embrace both the collisionless and the collisional regimes. A comparison of the observed confinement times and those derived from recent theories is given. The enhanced diffusion predicted for the intermediate and collisionless regimes has been shown by various authors to be explicable theoretically in terms of a unidirectional current flowing along the minor axis of the torus. The experimental evidence for the existence of this current is summarized. (auth)

38374 (CONF-710607-107) DEPENDENCE OF PLASMA CONFINEMENT ON THE PROPERTIES OF MAGNETIC CONFIGURATION AND PLASMAS IN J.I.P.P. STELLARATOR. Miyamoto, Kenro; Mohri, Akihiro; Inoue, Nobuyuki; Fujiwara, Masami; Yatsu, Kiyoshi; Terashima, Yoshinosuke; Itatani, Ryohei (Nagoya Univ. (Japan). Inst. of Plasma Physics). 17 Jun 1971. 15p. (CN-28/H-7). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Dependence of plasma confinement on the properties of the stellarator field as well as on plasma parameters is studied using the J.I.P.P. stellarator with several kinds of plasma sources. The observed diffusion coefficients are $\frac{1}{20} \sim \frac{1}{30}$ times the Bohm coefficient. A circular l = 3 stellarator with a vertical field is constructed with good geometrical accuracy using numerically controlled machines. The helical winding has a minor radius of 10.6 cm and major radius of 50 cm with 8 field periods. Two halves of the stainless steel vacuum vessel with inner radius of 8.4 cm are insulated by ceramic spacers to make the ohmic heating method possible. The stationary (5 s) magnetic field is 4 kG at maximum and the rotational transform angle ι is up to 1.7 π and the shear parameter is up to 0.15. The well depth is variable from −5% to 10%. This device can be used in the torsatron configuration. Plasma sources used are a J × B type gun with a fast acting valve ($T_e \simeq 0.2 \sim 3$ eV, $n = 10^{9\sim10}$ cm^{-3}), ECRH ($T_e \sim 2$ eV, $n \sim 10^{10}$ cm^{-3}) and ohmic heating by an air core coil ($T_e \sim 3$ eV, $n \sim 10^{10\sim12}$ cm^{-3}). The winding of the air core coil is arranged so that the disturbance due to the stray field is negligibly small within the plasma region. These plasma parameters cover a range of the intermediate collisional and collisional regions. It is observed that the diffusion coefficients D estimated from the decay times and the plasma radius a are proportional to the 1st to 2nd power of the rotational transform angle ι. The profile of the density distribution is similar to $\cos[1.57(r/a)^2]$ or $(r/a)^2 J_{-\frac{1}{4}}[1.25(r/a)^3]$ which are solutions of the diffusion equation with diffusion coefficients $D \propto r^{-2}(\propto \iota^{-1})$ or $D \propto r^{-4}(\propto \iota^{-2})$ (r is the radial coordinates). The confinement times do not depend appreciably on the properties of the magnetic well (and antiwell), and the dependence of confinement on the magnitude of the magnetic field is linear in the experimental conditions. The two-dimensional distributions of the densities and the potentials of plasmas produced by the J × B type gun and ECRH show the existence of convective motion due to the electric fields possibly caused by trapped electrons and the toroidal drift. The plasma near the center regions is transported across the field to the boundary where the density gradient exists and the fluctuations due to drift waves are observed. Transport by convection and the fluctuations can roughly explain the observed confinement time. (auth)

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38375 (CONF-710607-108) PLASMA CONFINEMENT EXPERIMENT ON THE HELIOTRON D MACHINE. Uo, Koji; Iiyoshi, Atsuo; Yoshioka, Shoji; Ishida, Tatsuo; Konoshima, Shigeru (Kyoto Univ. (Japan)); Sato, Motoyasu (Keio Univ., Tokyo (Japan)). 17 Jun 1971. 19p. (CN-28/H-8). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The Heliotron D is a toroidal machine having the helical heliotron field as a confining magnetic field. By changing the combination of the three kinds of field produced by the helical, toroidal, and vertical field coils, various kinds of helical heliotron field were obtained. The maximum rotational transform angle of the field is more than 9π and the shear parameter is over 2.0. It is possible to form a shallow magnetic well or an antiwell by changing α = B(toroidal)/B(helical). Plasma of $n_e = 10^8 \sim 10^{10}$ cm^{-3} and $T_e = 1 \sim 20$ eV is produced by ECRH and gun. The neutral-particle density is typically 5×10^{12} cm^{-3} for ECRH plasma and 10^{11} cm^{-3} for gun plasma. The plasma is weakly ionized. The effect of the vertical field on confinement is examined and the optimum β = B(vertical)/B(helical) is determined. The equidensity contour nearly coincides with the calculated magnetic surface, and the density profile has a sharp boundary. Under optimum conditions the confinement time is about 40 times Bohm time. For gun plasma, observed confinement time is a few tenths of the value predicted by "neoclassical" theory in an asymmetric toroidal system. (auth)

38376 (CONF-710607-109) INVESTIGATIONS OF THE ELECTRICAL CONDUCTIVITY AND CURRENT HEATING OF PLASMA IN A STRONG STELLARATOR MAGNETIC FIELD. Burchenko, P. Ya.; Volkov, E. D.; Rudakov, V. A.; Sizonenko, V. L.; Stepanov, K. N. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 17 Jun 1971. 16p. (In Russian). (CN-28/H-9). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The results are given of a study, with electric fields from $E = (0.01 \text{ to } 100)\ E_k$, of the electrical conductivity of a plasma in a strong magnetic field $H_0 > (4\pi m_e c^2 n_e)^{1/2}$. Here $E_k = 1.36 \times 10^{-12}$, (N_e/T_e) is the Dreicer critical field, n_e the plasma density, m_e the electron mass, T_e the electron temperature of the plasma, and c the speed of light. It is shown that when the electric field $E = (0.1 \text{ to } 0.7)$ v/cm and the plasma density $n_e = (2 \text{ to } 4) \times 10^{12}$ cm^3, the electrical conductivity of the plasma σ is inversely proportional to E. The current velocity of the electrons, u, in the region $10 < (E/E_k) < 100$ tends to saturation. At the same time a linear relationship is observed between the current and thermal velocities of the electrons $u \approx 0.1\ V_{Te}$. The relationship between the resistance anomaly ($^{\sigma}CT/\sigma$) and (E/E_k) is also linear in the region $0.1 < (E/E_k) < 100$. Here, σ_{CT} is the Coulomb conductivity calculated on the basis of the temperature determined from measurements of the plasma diamagnetism. The electrical conductivity anomaly reaches values of the order of 10^3 when $(E/E_k) = 100$. When such an anomaly exists, the plasma temperature $T = T_e + \xi T_i$ amounts to 500 to 600 eV at a density $n_e = (2 \text{ to } 4) \times 10^{12}$ cm^{-3}. A comparison is made with data obtained during previous experiments carried out in a narrower range of (E/E_k) in various closed magnetic traps. An explanation is offered for the data obtained on the basis of assumptions regarding the buildup of ion-acoustic instability. It is assumed that the stabilization of unstable ion-acoustic oscillations occurs when the movement of resonance electrons in the field of these oscillations becomes strongly nonlinear, namely when their oscillation velocity attains the order of the wave phase velocity. Deceleration of the greater part of the nonresonance electrons and, consequently, the occurrence of an anomalous resistance, may be caused by the scattering of the electrons by oscillations, the phase of which undergoes arbitrary changes in a nonlinear régime. On the assumption that the correlation time of the Fourier components of the oscillational electric field is of the order of the inverse nonlinear decrement of attenuation, an expression was obtained for the conductivity of the plasma. (auth)

38377 (CONF-710607-110) EXPERIMENTAL RESEARCH ON MAGNETIC SURFACES AND PLASMA CONFINEMENT IN THE "SATURN-1" THREE-TURN STELLARATOR-TORSATRON. Voitsenya, V. S.; Georgievskii, A. V.; Ziser, V. E.; Pogozhev, D. P.; Skibenko, A. I.; Solodovchenko, S. I.; Suprunenko, V. A.; Tolok, V. T.; Fomin, I. P.; Dushin, L. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 17 Jun 1971. 33p. (In Russian). (CN-28/H-10). Dep. NTIS (U. S. Sales Only).

From fourth conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The "Saturn-1" toroidal trap is designed for the investigation of the properties of a magnetic field of various configurations and their effect on the plasma confinement. The design of the device allows the creation of two types of magnetic configuration: a three-turn stellarator and a three-turn torsatron configuration. The main parameters of the trap are as follows: magnetic field strength $H_0 \leq 6$ kOe; major radius of the torus R = 35.6 cm; minor radius of the spiral winding a = 10 cm; inside radius of the vacuum chamber r = 8.6 cm; number of periods of the magnetic field m = 8. Experimental investigations of the magnetic surfaces were carried out with the help of pulsed low-energy electron beams. The results were compared with calculations on a BESM-6 computer. The investigations of the torsatron configuration have shown that closed surfaces exist over a wide range of changes in the components of the magnetic field: $0.4 \leq k\varphi = H\varphi B/H_0 \leq 1$, $0.5\% \leq H\perp/H_0 \leq 1.5\%$, where $H\varphi B$ is the longitudinal field created by the helical winding and $H\perp$ the vertical field for formation of a magnetic well. When a longitudinal field is produced only by a helical winding ($K\varphi = 1$), the rotational transform angle and shear are rather high ($i_0 \sim 0.9\pi$, $S_0 \sim 0.12$). The optimum conditions, however, are realized when $k\varphi = 0.66$ and are characterized by the following values: $i_0 = 0.8\pi$, $S_0 \sim 0.2$ and $r_0 \sim 5$ cm (r_0 is the average radius of the outermost undestroyed surface). In the stellarator regime under optimum conditions, these values are equal to $\sim\pi$, ~0.25 and ~4.8, respectively. Both in the torsatron and the stellarator configurations the superposition of a small vertical field leads to the occurrence of a magnetic well (~10%) while a moderate shear value (~0.05) is maintained. The traps were filled with plasma by external injection from several titanium sources arranged near the outermost undestroyed surface. The parameters of the trapped plasma were measured approximately 0.5 ms after the triggering of the sources. The dependence of the plasma confinement time τ_n on the value of the longitudinal field and on the field ratio in both stellarator and torsatron regimes was investigated. Investigations of the radial density distribution with the help of twin electric probes showed that the plasma boundary approximately coincides with the outermost undestroyed surface. The quoted confinement time $\tau_n' = \tau_n(r^2/r_{nl}^2)$, where r_{nl} is the plasma radius, increases with the increase in the helical harmonic of the magnetic field in both torsatron and stellarator regimes. (auth)

38378 (CONF-710607-111) BEHAVIOUR OF A HIGH-TEMPERATURE PLASMA UNDER CURRENT HEATING IN THE HIGH-SHEAR STELLARATOR URAGAN. Dikii, A. G.; Gorman, Dzh. G.; Zalkind, V. M.; Zelenin, G. V.; Kotsubanov, V. D.; Litvinov, A. P.; Pavlichenko, O. S.; Perepelkin, N. F.; Ponomarenko, N. P.; Suprunenko, V. A.; Tolok, V. T.; Tonkopryad, V. M. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 17 Jun 1971. 22p. (In Russian). (CN-28/H-11). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The following plasma parameters were measured: electron density by means of a phase meter, electron temperature on the basis of the plasma conductivity, and the ratio of the intensities of the spectral lines of helium. The radial distribution of the electron density and temperature was measured with the help of electric probes. Under some conditions control measurements were made of the radial distributions of the electron temperature and concentration on the basis of the Thomson scattering of light from a ruby laser. Results are given of measurements of the energy lifetime and the charged-particle lifetime as a function of the configuration of the magnetic field in the stellarator. When measuring the charged-particle lifetime, account was taken of the effect of ionization by the spectroscopic method. In typical operating regimes the electron density attained 10^{13} cm^{-3} and the electron temperature up to 100 eV. Attempts to separate the effect of shear and the rotational transform angle are discussed, using the specific behavior of the shear and rotational transform values when the increase $\epsilon = h_3/H_z$ (h_3 is the fundamental harmonic of the helical field and H_z the strength of the longitudinal magnetic field). (auth)

38379 (CONF-710607-112) PLASMA SHIFT IN FAST STELLARATORS WITH FINITE CONDUCTIVITY. Pfirsch, D.; Schlueter, A. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 17 Jun 1971. 4p. (CN-28/H-12). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The magnetohydrodynamic theory of low-β stellarator and Tokamak equilibria shows that finite electric conductivity demands rather large plasma flows. In a fast-compression stellarator the question arises whether these flows can be set up fast enough to avoid the plasma hitting the walls. Two cases are considered: (1) There is a vacuum between the plasma and the

wall, and the plasma has already shifted out of the magnetic surfaces such that, in the most pessimistic idealization, no secondary currents can flow along the lines of force. The plasma is then accelerated in a radial direction until the necessary plasma flows are established. The resulting total shift S_r of the plasma was estimated to be: $[\delta r_1 = (\frac{1}{2})(v_D^2/v_i^2)(2\pi/\theta)^3 (R/r_p)^5 r_p]$. v_D is the classical diffusion velocity without any torus corrections, v_i the thermal ion velocity $(kT_i/m_i)^{1/2}$, R the major torus radius, r_p the small plasma radius, and θ the angle of rotational transform. (2) The same finite conductivity exists throughout the volume inside the walls. An optimistic assumption would be that the radial flow of the plasma already exists, permitting the secondary currents to flow. Due to this radial flow the plasma moves until the plasma flow in toroidal direction is achieved. The shift is $[\delta r_2 = (v_D^2/v_i^2)(2\pi/\theta)^6 (R/r_p)^4 r_p]$. The truth might be somewhere between δr_1 and δr_2. These relations make it desirable to use configurations with only small secondary currents. This could be attained, for instance, by corrugating the magnetic lines of force to a certain degree. (auth)

38380 (CONF-710607–113) CONFINEMENT OF A TOROIDAL THETA-PINCH PLASMA IN A PERIODIC CAULKED CUSP FIELD. Uchida, Taijiro; Sato, Koichi; Mohri, Akihiro; Akiyama, Riuichi (Nagoya Univ. (Japan). Inst. of Plasma Physics). 17 Jun 1971. 10p. (CN–28/J-1). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

It was established with a toroidal theta-pinch experiment that a periodic caulked cusp field is effective in the suppression of the toroidal drift of a high-beta plasma as well as in the stabilization. This caulked cusp field is generated from currents induced by the theta-pinch magnetic field in the metal rings placed, perpendicularly to the main field, inside the discharge tube. The current in the ring is simply inductive, and a closed line of null field lies inside each ring. Owing to the skin effect of the ring conductor, the null field line remains during the discharge. Experiments were carried out on a toroidal machine with a theta-pinch coil of 50-cm major diameter and 13-cm minor diameter, equipped with 24 ceramic-coated metal rings inside. On the implosion phase the plasma sheath contracts uniformly in space except for the ring planes, and the axial inhomogeneity of the produced plasma that might result from the insertion of rings is hindered fairly well by a negative bias field applied to preheated plasma. The plasma is located at several mm outside of the tube axis at the final stage of contraction. In order to get a favorable result for the confinement of the pinch plasma, there should be a region in which there exists a magnetic field minimum on the midplane between neighboring rings, and the region should correspond to the plasma location at the maximum contraction. The number "24" for the rings is chosen so as to satisfy these conditions and the plasma is really observed to stay at this location. Some flute-like instabilities are observed when 12 rings are used, in which case there is no region of field minimum. The dynamics of the implosion phase are studied by magnetic probes, spectroscopy, and laser techniques. The plasma behavior in a periodic caulked-cusp field is discussed for a plasma with Doppler temperature of several tens of eV, density of 1×10^{16} cm^{-3}, and beta ratio of $0.1 \sim 0.2$. (auth)

38381 (CONF-710607–114) TOROIDAL HIGH β EXPERIMENTS IN COMPACT AXISYMMETRIC CONFIGURATIONS. Belitz, H. J.; Janicke, L.; Noll, P.; Plantikow, U.; Sand, F.; Schlueter, J.; Waelbroeck, F.; Waidmann, G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). 17 Jun 1971. 14p. (CN–28/J-2). Dep. NTIS (U. S. Sales Only).

From fourth conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Plasmas heated by fast-rising ($\dot{B}/B \approx 1$ μsec) and confined by slow-decaying ($|\dot{B}/B| > 1$ msec) magnetic fields were studied in axisymmetric toroidal configurations. Small aspect ratios R/a (R = major radius, a = characteristic minor dimension) are chosen to reach relatively high current densities and to confine plasmas of higher β below the Kruskal–Shafranov (K.S.) limit. In the first experiment (helical hard-core theta pinch), plasmas with temperatures $T \approx 20$ eV, densities $n > 10^{16}$ cm^{-3} and strongly elliptical (typically b/a = 3) cross sections are produced at the end of the fast compression. By adjusting the voltages and currents of the hard core and the theta coil, and the time-delay between switching the banks, R can be varied and the net plasma momentum in r direction can be made ≈ 0 at the end of the dynamic phase. Slower variations of R, resulting from the diffusion of the toroidal field into the plasma (β decreases down to 15% in a few μsec), and from the contraction of the plasma cross section in the z direction, occur later. They can be controlled by programming the hard-core current. Theoretical results on the equilibrium plasma configuration agree with the result of magnetic probe and optical measurements, which indicate further some triangular deformation of the plasma cross section. Outside the plasma, a vacuum magnetic field configuration is observed. The rotational transform angle ι was varied by changing R and the ellipticity; the plasma appears hydromagnetically stable when $q = 2\pi/\iota > 2.5$. The observed confinement time ($\approx$30 μsec) agrees then with the decay time of the toroidal plasma current and can be explained by the relatively low plasma temperature. The second experiment is being built to study the high-β stability limit in a torus with circular cross section and larger dimensions (R = 25 cm, r_w = 10 cm). The toroidal magnetic field ($\leq$10 kG) and the discharge current rise simultaneously in 1.6 μsec. It will be attempted to reach temperatures $\geq$200 eV at densities $n_e = 3 \times 10^{14}$ to 10^{15} cm^{-3}. The rf pre-ionization and the preheat stage of this experiment were studied using a similar coil system and a small capacitor bank (T = 11 to 30 μsec). At the required small gas pressures of typically 1 mtorr, optimum breakdown occurs at voltages of $\approx$1.5 kV per turn; at higher voltages, runaway electrons are indicated. The preheat discharge produces thin plasmas with $T_e = 2$ to 4 eV, n_e (spatially resolved) = 10^{13} to $\geq 6 \times 10^{13}$ cm^{-3} and a toroidal current of several kA. (auth)

38382 (CONF-710607–119) PLASMA CONTAINMENT IN CLOSED LINE SYSTEMS. Grad, Harold (New York Univ., N. Y. Courant Inst. of Mathematical Sciences). 17 Jun 1971. 14p. (CN–28/J-7). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Plasma equilibria with exact magnetic surfaces are obtained only in configurations with an ignorable coordinate. Equilibria with closed magnetic lines result from a different symmetry, reflection in a plane. The appropriate analytical methods and the ensuing plasma properties differ profoundly for magnetic-surface and closed-line equilibria. The general theory is developed for scalar pressure and guiding-center models, and a number of special results were calculated for a bumpy torus with small toroidal curvature. On occasion, the toroidally perturbed pressure profile develops islands ("bananas"). Classical resistive diffusion is atypical; the standard procedures fail, and diffusion does not follow the standard $1/B^2$ formula. (auth)

38383 (CONF-710607–120) PLASMA HEATING BY STRONG SHOCK WAVES. Chen, Y. G.; Chu, C. K.; Gross, R. A.; Halmoy, E.; Moriette, P.; Schneider, S. (Columbia Univ., New York). 17 Jun 1971. 16p. (CN–28/J-8). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

About 10^4 cm^3 of plasma at $T \sim 1$ keV, $n \sim 1 \times 10^{16}$ cm^{-3}, were created by fast collisional shock waves in an electromagnetic shock tube. The speed of these shock waves ranges up to 4×10^8 cm/sec, corresponding to an acoustic Mach number of 3,200 and an Alfvén Mach number of 15. These experiments were performed in a 3-meter-long coaxial electromagnetic shock tube, employing a 60-μf, 120-kV capacitor bank that produces a 2×10^6-A drive current. The preshock hydrogen initial state was T = 293°K, p = 50 mtorr. The preshock 7.2-kG transverse magnetic field was used to keep the shock thickness small and retard plasma interaction with the walls. Separation of the transverse ionizing shock wave from the driving current was clearly observed, and a hot dense plasma was created behind the shock wave. The state of this plasma was determined by laser-interferometer measurements, x-ray bremsstrahlung spectra, a particle energy analyzer, probes, and neutron detectors. The shock-created plasma contained an azimuthal magnetic field of $B \sim 22$ kG. When deuterium gas was used, a yield of about 5×10^3 neutrons per shot was estimated. The transverse ionizing shock thickness, as determined by magnetic field structure, was found to be from 5- to 80-cm thick, the larger values occurring at higher shock speeds. These thicknesses are found to agree with the calculations made from a two-fluid MHD computer code employing classical plasma transport properties. The calculated structure of these collisional shock waves predicts that the ion temperature substantially exceeds the electron temperature. (auth)

38384 (CONF-710607–123) SHOCK WAVES AND TURBULENT HEATING IN LOW DENSITY PLASMAS. Bogen, P.; Dietz, K. J.; Dippel, K. H.; Hintz, E.; Hoethker, K.; Siemsen, F.; Zeyer, G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). 17 Jun 1971. 17p. (CN–28/J-11). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Shock heating and shock structures are studied in theta-pinch-like devices in a wide range of plasma parameters n_{e1}, B_{t1}, m_i, and of wave speeds $u_1 (3 \times 10^6 \text{ cm sec}^{-1} \leq u_1 \leq 10^8 \text{ cm sec}^{-1})$. Densities and temperatures were determined locally by interferometry and by Thomson scattering. Magnetic and electric fields were measured with small high-frequency probes. Pre-

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vious investigations of perpendicular, hydromagnetic shocks at $\beta_i \ll 1$ and $M_A < M_{A,critical}$ at densities above 10^{14} cm^{-3} are extended to densities close to 10^{13} cm^{-3} and to other mass ratios m_e/m_i. Shocks are nearly collision-free even with respect to the initial state. A scaling law is obtained for the effective collision frequency ν_{eff}, deduced from measured turbulent heating rates and current densities. Results show that $\nu_{eff} \approx 10^{-3} (T_e/T_i) \cdot (v_d/c_s)\omega_{pi}$. Studies are extended to small Alfvén Mach numbers, where shock structures are still collision-dominated. Comparison with theory shows good agreement. In the same density range, shocks are generated at $\beta_i \approx 0.3$, and with $M_A \gg M_{A,critical}$. From the observed electron heating rates and the electron density jump, together with the shock relations, estimates for turbulent ion heating rates are obtained. Investigation of the structure of collision-dominated shocks in magnetic field-free plasma shows that the electron temperature and density front are well separated; the width of separation agrees with theoretical estimates. Attempts are made to heat low density ($n \leq 10^{13}$ cm^{-3}), magnetic field free plasma by fast magnetic compression. In deuterium an anomalously broad current sheath is observed. Nevertheless, deuteron temperatures of ≈10 keV and relatively high values of the local $\beta(\beta \approx 10)$ are achieved in a low-energy theta pinch (≈10 kJ). Electric and magnetic field fluctuations of large amplitude occur. In argon, at large radii, a stationary electromagnetic sheath is found with a width of a few c/ω_{pe} and an electric potential jump as required by theory. Ion energies and compression ratios observed at maximum compression are in accord with implosion velocities. (auth)

38385 (CONF-710607–124) ION HEATING IN A HIGH VOLTAGE THETA PINCH. Davis, W. D.; DeSilva, A. W.; Dove, W. F.; Griem, H. R.; Krall, N. A.; Liewer, P. C. (Maryland Univ., College Park. Dept. of Physics and Astronomy). 17 Jun 1971. 20p. (CN–28/J-12).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The interaction of a low-beta, 10^{12} cm$^{-3} \lesssim n_e \lesssim 3 \times 10^{13}$ cm^{-3}, $kT_e \approx kT_i \lesssim 2$ eV highly but not completely ionized plasma with a fast-rising magnetic field ($B(0) \lesssim 2 \times 10^4$ G/μsec) was studied in a large theta pinch with 100-cm coil length and 46-cm inside diameter of the discharge tube. Depending on initial plasma conditions, the magnetic field penetrates into the plasma either by an anomalous diffusion, a collision-free compression, or a combination of both modes of penetration. Doppler-broadened and -shifted line emission from charge-exchange neutrals is used to determine the ion dynamics in $6 \lesssim$ Mach $\lesssim 26$ flows. Large Doppler shifts show that ions are accelerated up to twice the magnetic piston speeds, while Doppler broadening gives large ion heating rates (≲10 keV/μsec), leading to temperatures of ~5 keV at about half the design voltage on the fast energy storage. Much of this ion heating is seen behind the "leaky" piston. These ion heating rates and temperatures are supported by space- and time-resolved neutron observations. The latter further suggest that ion temperatures increase at least linearly with the stored electrical energy and that a factor ~2 increase can be obtained by optimizing initial plasma parameters. Maximum electron temperatures tend to be below, or nearly equal to, the ion temperatures. These measurements, together with electric field fluctuation measurements, help to distinguish among the various theoretical models for acceleration and heating mechanisms that contribute to the large efficiency of conversion from electrical to plasma energy obtained in this experiment. (auth)

38386 (CONF-710607–125) HEATING INDUCED CONDITIONS AND ITS MECHANISM OF THETA PINCH PLASMAS. Kiyama, Satoru; Ogawa, Kiyoshi (Ministry of International Trade and Industry, Tokyo (Japan)). 17 Jun 1971. 12p. (CN–28/J-13). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The heating rate of plasma at the initial compression phase of the θ pinch is obtained for the various conditions and its heating mechanism is investigated using a newly constructed 8-kJ fast θ-pinch device. The magnetic field rise of this θ-pinch device is very large and variable over a wide range (5×10^{10} to 2×10^9 G/sec), keeping the maximum magnetic field at a fixed value and varying the other parameters. The θ-preheating in this device is almost perfect, employing the transmission energy storage system, and is able to fire even in the very-low-pressure régime below 10^{-3} torr. The plasma is remarkably heated in the region where the magnetic field rise is larger than a certain value (2×10^{10} G/sec which corresponds to the maximum induced electric field of 400 V/cm in the discharge tube). This value of the magnetic field rise where the heating rate changes markedly, and the total absorbed energy by the plasma which is a fairly large fraction of the storage energy of the capacitor bank (up to 30%), are almost independent of the initial gas pressure over the wide range (3 to 300 mtorr). Then the temperature of plasma is very high (over 1 keV) in the low-pressure régime, and the sharp shock structure is not always observed in this θ pinch. For the heating mechanism of the θ-pinch plasma, it is suggested that turbulent heating, shock heating, and adiabatic heating should be separately treated in the various regions of the compression stage and of the magnetic field rise. Especially in the low-pressure régime and at the high magnetic field rise, the turbulent heating by the anomalous resistance is an important mechanism. This is strongly related to the collective phenomena of plasma and has important effects on the formation and the structure of the shock immediately following. Experimental and theoretical investigations are proceeding in an attempt to understand these phenomena. (auth)

38387 (CONF-710607–137) NEOCLASSICAL THEORY OF MAGNETIC PUMPING IN TOROIDAL GEOMETRY. Canobbio, Ernesto (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 17 Jun 1971. 17p. (CN–28/L-1). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The heating of a low-β plasma confined in a toroidal system by Transit-Time Magnetic Pumping (TTMP) is investigated in the case of an arbitrary toroidal low-frequency magnetic configuration, in the limit of low collision frequency ($\nu_{ii} < \omega$) with no restriction on both T_e/T_i (the ratio of electron to ion temperature) and $-j_z/en$ (the parallel electron drift velocity). In particular, one considers (i) a toroidal bumpy rf-field modulation as produced by a conventional array of meridian coils, (ii) a toroidal $l = 1$ helical rf field obtained by properly modulating the current flowing in some helical windings, and (iii) the pure radial field produced by Koechlin–Samain coils. In cases (i) and (ii), when the wave length is comparable to the major radius of the torus, a significant additional heating takes place because of the work done by the electric field on the toroidal drift when the magnetic axis is acted upon by the pumping wave. On the other hand, it is found that at relatively high current flow, TTMP can be inhibited by overstability. The heating rate is maximum in the intermediate collision frequency range $\nu_c < \nu_{ii} < \omega$, where it is independent of collisions, while it is ν_{ii}/ν_c times smaller at very low collision frequency because of the nonlinear distortion of the distribution function of resonant particles. By using the same variational procedure as Rosenbluth for the toroidal diffusion coefficients in the "banana" regime, a much more precise evaluation of both the heating rate at $\nu_{ii} \ll \nu_c$ and the value of ν_c may now be given. Finally, since the heating rate even at moderate rf-power level can be made much larger than the plasma loss rate in low-β tori, it is concluded that TTMP is a powerful potential method to reach reactor temperatures in tokamaks and stellarators. (auth)

38388 (CONF-710607–138) NEW METHOD OF MAGNETIC PUMPING FOR PLASMA HEATING. Koechlin, F.; Samain, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 17 Jun 1971. 11p. (In French). (CN–28/L-2). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A new method of magnetic pumping is proposed in which torsion of the static field lines is used instead of compression of the field; the oscillating magnetic field is perpendicular to the static field. The curvature of the lines of force of the static configuration plays an important part in the heating process: the force that heats the particles is the component, along the magnetic perturbation, of the centrifugal force due to thermal motion of the particles. The arrangement proposed is effective in configurations with a large aspect ratio, such as Tokamak configurations. In this case, the most efficient perturbation has the azimuthal wave number 1 around the magnetic axis and around the principal axis. The optimal pumping frequency is of the order of the inverse of the transit time around the principal axis. It is typically three times less than the optimal frequency for compressional magnetic pumping. However, heating of the particles is twice as strong for equal magnetic perturbations. The increase in the heating power due to the electrostatic field accompanying the magnetic perturbation and the plasma diffusion induced by this perturbation were estimated. (auth)

38389 (CONF-710607–141) RESEARCH ON ULTRA-HIGH-FREQUENCY HEATING AND ADIABATIC COMPRESSION OF A PLASMA IN THE TUMAN-2 FACILITY. Anisimov, A. I.; Vinogradov, N. I.; Golant, V. E.; Ipatov, V. A.; Kaganskii, M. G.; Kalmykov, S. G.; Kislyakov, A. I.; Ovsyannikov, V. A.; Pakhomov, L. P.; Podushnikova, K. A.; Tyul'panov, S. S.; Shakhovets, K. G. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut).

17 Jun 1971. 23p. (In Russian). (CN-28/L-5). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Experiments conducted in the recently constructed toroidal device "Tuman-2" are described. The toroidal discharge chamber of the device has a major radius of 80 cm and a minor radius of 20 cm. The strength of the quasi-stationary magnetic field can be varied up to 10 kOe (τ = 10 ms). As in the Tokamak systems, the equilibrium of the plasma column is ensured by the interaction of the longitudinal current with the casing and with a programmed transverse field. Provision is made in the device for three-stage heating of the plasma. The first stage comprises ohmic heating in conditions similar to those prevalent in Tokamaks, the second stage heating with uhf fields, and the third stage adiabatic compression. Ultra-high-frequency heating is effected by means of generators operating in frequency bands of approximately 10 and 40 Gc with an output of up to 100 kW at a pulse duration of 100 μs. Adiabatic compression is brought about by strengthening the longitudinal magnetic field for periods shorter than the transverse diffusion time (70 to 100 μs). At the present stage of the experiment, the maximum contracting field is 15 kOe. During an ohmic heating régime in the device, a plasma was obtained with a concentration of 10^{12} to 10^{13} cm^{-3} and a temperature of some tens of eV. Investigations were made on the absorption of uhf energy in the frequency bands of 10 and 40 Gc and on plasma heating under the influence of this energy. During the investigations it is intended to establish the effectiveness of introducing uhf energy, the localization of the absorption region, and the effect of uhf heating on the plasma confinement. On the basis of experiments carried out earlier, absorption under the conditions of the experiment may be expected to be associated with transformation of the uhf waves introduced from outside into slow, rapidly attenuating plasma waves. Using two frequency bands and varying the plasma parameters (magnetic field and density) it is possible to move the transformation region throughout the whole volume and to establish the optimum conditions for introducing energy into the plasma. In the following stage adiabatic compression of previously heated plasma will be brought about, and the change in the plasma parameters during compression will be studied. (auth)

38390 (CONF-710607-142) EXPERIMENTAL INVESTIGATION OF PLASMA HEATING AT A FREQUENCY CLOSE TO THE LOWER HYBRID RESONANCE. Glagolev, V. M.; Krivov, N. A.; Skosyrev, Yu. V. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 19p. (In Russian). (CN-28/L-6). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

When an electromagnetic wave excited in a plasma is slowed down as it moves along the magnetic field and propagates across the field in the direction of increasing density, it is transformed into a plasma wave. The collisionless absorption of the hf power of a plasma and the heating of a plasma were studied. A plasma produced by a uhf discharge or a plasma gun and having a density of 2×10^{12} cm^{-3} with a neutral gas pressure of (1.5 to 3) $\times$ 10^{-4} mm Hg is injected into a uniform magnetic field of 3 kOe. Ion-hybrid waves are excited with the help of a coil wound around a quartz tube (diameter 60 mm), which is connected to the injector. The power of the heat generator, which operates at a frequency of 140 Mc, is 200 kW for pulse duration of 100 μs. The electron velocity distribution along the magnetic field and the transverse and longitudinal ion velocity distribution are studied with the help of multigrid probes and an electrostatic ion energy analyzer. The probes, which move along the radius, provide data on the distribution of the hot ions and the electrons over the cross section of the plasma. The electron distribution has a minimum at the center of the plasma column, whereas the density of the heated ions is at a maximum. The transverse plasma energy, determined by measuring the diamagnetism of the plasma, increases with the magnetic field, beginning with a field corresponding to the hybrid resonance of a dense cold plasma. These results agree with the fully developed theory. The temperature of the plasma and its variations over time are determined by comparing the diamagnetic signal and the density of the plasma, measured with the help of 4- and 8-mm radio interferometers. The maximum temperature of the heated plasma is (1.5 to 2) $\times$ 10^{14} eV cm^{-3} for a density of 2×10^{12} cm^{-3}. The mean transverse ion energy, found from probe measurements, is 150 eV. The energy of the electrons leaving the discharge along the magnetic field is 50 to 100 eV. Ions with a longitudinal energy of up to 600 eV are observed. (auth)

38391 (CONF-710607-143) RESEARCH ON HIGH-FREQUENCY HEATING OF A PLASMA. Grigor'eva, L. I.; Longinov, A. V.; Pyatak, A. I.; Sizonenko, V. L.; Smerdov, B. I.; Stepanov, K. N.; Chechkin, V. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 17 Jun 1971. 30p. (In Russian). (CN-28/L-7). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

It is shown that the high-frequency method of plasma heating employing a collisionless wave absorption mechanism under the resonance conditions $\omega = K_{||} v_{||} + n\omega_{Bα}$ can ensure heating of a dense plasma of large dimensions to thermonuclear temperatures. The absorption of the high-frequency energy is affected by resonance particles. The Coulomb collisions of these particles with the remaining particles of the plasma prevent the formation of a plateau in the distribution function and ensure heating of all the plasma. Attention is devoted to the heating of a large volume of plasma with the help of fast magneto-acoustic waves and forced oscillations. A theoretical investigation was made of the turbulence of a plasma with a transverse current for the case in which the relative velocity of the electrons and ions "U" is considerably less than the electron thermal velocity. A review is given of cases of strongly non-isothermic plasma ($T_e \gg T_i$), where oblique ion-acoustic oscillations may be excited, and of isothermic plasma ($T_e \approx T_i$) close to the boundary of the stable region. The case of hydrodynamic instability, where $U \gg \sqrt{(T_e + T_i)/m_i}$ is also considered. Estimates are given of the level of turbulence and the rate of electron and ion heating. Attention is also devoted to the instability of a plasma with a transverse current under conditions of finite pressure ($\beta = 8\pi nT_{e,i}/B^2 \geq 1$). Results are presented of experiments on the investigation of turbulence and the heating of a hydrogen plasma with fast magneto-acoustic and ion-cyclotron waves of high amplitude. Measurements were made of the spectra of turbulent pulses and the noise level, and the conditions were determined in which preferential heating of electrons or ions occurs. (auth)

38392 (CONF-710607-144) EXPERIMENTS ON HIGH-FREQUENCY HEATING OF A PLASMA IN A TOROIDAL TRAP. Ovchinnikov, S. S.; Kalinichenko, S. S.; Kurilko, V. I.; Shvets, O. M.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 17 Jun 1971. 38p. (In Russian). (CN-28/L-8). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The excitation and propagation of low-frequency waves ($\omega^2 \ll \omega_{ci}\omega_{ce}$) in a high-density plasma ($\omega_{pe}^2 \gg \omega_{ci}\omega_{ce}$) contained in a toroidal trap were studied. The plasma was produced by means of an electron beam. Conditions were found for the effective introduction of high-frequency power into the plasma by means of exciting devices arranged inside the conducting vacuum chamber. A study of the structure of the excited waves shows that axially asymmetric waves are those most effectively produced in a toroidal plasma. The possibility was experimentally investigated of heating the plasma ions to high energies with axially asymmetric ion-cyclotron waves. The high-frequency power was introduced at high levels by an exciting device that creates in the plasma a spatially periodic transverse high-frequency field. For recording of the plasma heating, the diamagnetic signal was measured and the ion energy spectrum was analyzed. (auth)

38393 (EUR-CEA-FC-579) A REPORT FROM THE GROUP STUDYING THE HEATING OF A PLASMA CONFINED IN A TOKAMAK TYPE MAGNETIC CONFIGURATION. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan 1971. 73p. (In French). Dep. NTIS (U. S. Sales Only).

Different methods of plasma heating were compared. Possibilities of using them, both in plasmas near thermonuclear conditions and in tokamak-type experiments, were tested. Three methods are particularly interesting according to these criteria: transit time magnetic pumping, ion cyclotron absorption, and fast-neutral injection. They are described in detail. (France)

38394 LIMITING PLASMA PRESSURE IN A TOKAMAK. Galeev, A. A.; Sagdeev, R. Z. (Inst. of Nuclear Physics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 13: No. 3, 113-14(5 Feb 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 3, 162-3(5 Feb 1971).

A limiting value for the plasma pressure $\beta = 4\pi p/B_0^2$ is calculated for two different pressure and current distributions at uniform temperature. (M.O.W.)

38395 INVESTIGATION OF PLASMA DRIFT AND EQUILIBRIUM IN A TOROIDAL MAGNETIC FIELD WITH DIVERTOR. Zykov, V. G.; Karpukhin, V. I.; Rudnev, N. I.; Tolok, V. T. (Inst.

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of Physics and Tech., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: 303-8(Feb 1971). (In Russian).

It is shown that a divertor magnetic field combined with a toroidal field decreases considerably the toroidal drift of a plasma stream. This is caused by the fact that a polarized electric field is removed by currents that flow along magnetic lines of force and are shortened through the annular region of the divertor where the magnetic field equals zero. (auth)

38396 EXPERIMENTS ON PLASMA INJECTION AND CONFINEMENT IN A TOROIDAL OCTUPOLE MAGNETIC FIELD. De La Fuente-Villarreal, Hector. Madison, Wis.; Univ. of Wisconsin (1970). 115p. University Microfilms Order No. 71-2211.

Thesis.

A small coaxial plasma gun with a lithium central electrode was used to study the effects of injection mode on the plasma behavior in a toroidal octupole magnetic field. The lithium plasma had $T_i \cong T_e \approx 25$ eV and densities $n \approx 10^{12}$ to 10^{13} cm^{-3} were obtained. The gun was small enough to be introduced into the octupole to inject plasma in the transverse mode at any point on the vertical median plane. An alternate version with a 90° bend was used to inject plasma along the minor axis of the octupole (θ-mode) or along magnetic field lines. The plasma trapping efficiency was found to depend on the injection mode being maximum when the plasma is injected in the θ-direction close to the inner side wall. During normal transverse injection the plasma is observed to hit the wall opposite injection. The flux of particles to the wall for 1 kV on the multipole bank is about 75% of the flux without magnetic field. When the plasma is injected along the minor axis of the octupole with the gun located at the zero field region, the density is peaked outside ψ_c, the field lines are not equipotential and the density is not constant along field lines. The density profile along the horizontal median plane has inverted density gradients $(\partial n/\partial \psi) > 0$, which are stable and decay smoothly without fluctuations. The plasma moves around the octupole for several hundred μsec, creating an octupole electric field. A floating-potential profile along the horizontal median plane reveals a convective cell-like structure. This convective motion affects the plasma lifetime which is about 100 μsec and increases to 400 μsec after the convective cell structure dies out. Plasma lifetime was observed to depend on the injection mode, being about 2.3 msec when the plasma is injected along field lines. It increases with the magnetic field strength until there are about 2 gyroradii between the outer hoop and ψ_c, then it remains almost constant. Fluctuations of the floating potential close to ψ_c for the confined lithium plasma were found to be negligible compared to the standard hydrogen plasma. (Diss. Abstr. Int., B)

38397 ENERGY LOSS FROM AN OPTICALLY THIN LAYER OF XENON PLASMA. Andreev, S. I.; Baikov, O. G.; Dashuk, P. N. High Temp. (USSR) (Engl. Transl.); 8: No. 5, 877-80 (Sep-Oct 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 5, 929-33(Sep-Oct 1970).

An experimental determination has been made of the loss of energy from a thin annular layer of xenon plasma, heated by a short-duration induced discharge, in the temperature range 12,000 to 42,000°K, at pressures of 3 to 20 atm. The power loss, per unit heavy particle, is a single-valued function of the temperature and is related to the radiative flux under these operating conditions. A method is suggested for determining the plasma temperature from the data on electrical power, measured at the moment of maximum plasma temperature. (auth)

38398 HEATING OF IONS IN HEAVY-CURRENT ARCS STABILIZED BY A MAGNETIC FIELD. Aref'ev, V. I.; Khmelinin, B. A. High Temp. (USSR) (Engl. Transl.); 8: No. 5, 1019-21 (Sep-Oct 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 5, 1091-3(Sep-Oct 1970).

The mechanism of the anomalous heating of ions in heavy-current arc discharges taking place in a longitudinal magnetic field is discussed on the basis of a model of inelastic scattering of ions by electric-field fluctuations induced by the instability of the discharge current. Currents flowing along the magnetic field are considered, and oscillations of the drift-type are shown to be unstable. Estimates are made of the limiting temperature of the ions for various ion types (Ar, N, and C); they agree with experiment in order of magnitude. (D.L.C.)

Diagnostics

Refer also to abstracts 37551, 38413, and 38416.

38399 (CONF-710607-39) STUDY OF PLASMA FOCUS BY THOMSON SCATTERING AND NEUTRON ANISOTROPY DURING NEUTRON EMISSION. Bernard, A.; Cesari, G.; Coudeville, A.; Jolas, A.; de Mascureau, J.; Watteau, J. P. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). 17 Jun 1971. 16p. (In French). (CN-28/D-4). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Thomson scattering measurements were carried out under the following conditions: 3 torr D_2, 18 kV, 15 kJ, $I_{max} = 500$ kA, and 2×10^9 neutrons. The spectrum of light scattered at 90° can be analyzed for 50 ns before neutron emission. In the case of an average point, identifying the experimental profile with a Salpeter profile, one gets $T_i = 370$ eV, $\beta = 0.7$, $v_{axial} = 2 \times 10^7$ cm s^{-1}. By Rayleigh scattering one can estimate: $N_e > 4 \times 10^{18}$ cm^{-3}, Salpeter α parameter >1.25 and $180 < T_e < 300$ eV. Comparisons are made with earlier results. No 90° scattering is observable during neutron emission. This is attributed to a broadening of the spectrum, which reduces the signal-to-noise ratio; the broadening could result from the rapid increase in T_e, which makes $\alpha < 1$ and the electron component of the spectrum preponderant as compared with the ion component. To keep $\alpha > 1$ during neutron emission, use is made of a 7° observation system, which has actually given scattering signals before and during neutron emission. These signals are resolved for λ using a Fabry–Pérot interferometer and 12 photomultipliers. The average number of neutrons measured with a "squirrel-cage" external electrode at 90° is between 1.5×10^9 and 3×10^{10} for 3 to 20 torr, 18 to 40 kV, 15 to 70 kJ, and 0.5 to 1.5 MA. These different conditions are obtained with good coupling between the energy bank and the plasma discharge: neutron emission then takes place when the current is a maximum, and the formation of an arc is avoided upstream of the plasma sheet. Such arcs cause a considerable part of the current to drift and prevent focusing. The number of neutrons per unit solid angle is measured at 0, 90, and 180°, particularly for the régime 40 kV, 70 kJ, and 1.5 MA with a large variation in pressure (10 to 20 torr). Various operating régimes are shown; these agree with the Potter calculations. (auth)

38400 (IPPJ-DT-22) MASS-ENERGY ANALYSIS FOR HIGHLY IONIZED STEADY STATE PLASMA. Ishimaru, Hajime (Nagoya Univ. (Japan). Inst. of Plasma Physics). Nov 1970. 67p. (In Japanese). Dep. NTIS (U. S. Sales Only).

An electrostatic-type energy analyzer, with energy resolution of 2 to 3% even in the energy region of 10 eV, was constructed. A time-of-flight-type mass spectrometer was also constructed, which works in combination with the former. Mass resolution of 10 to 30% was attained in this experiment. Fundamental variables of QP plasma were measured, such as energy distribution of ions, ratio of existing ions, etc. Maxwell distribution of the ions was ascertained for the QP plasma. Energy distribution function of the ions was theoretically analyzed and compared with experiment. The ion temperature of 2 to 5 eV was obtained for both H and He plasma. Ions of H^+, H_2^+, H_3^+ were found in the hydrogen plasma. (auth) (Japan)

38401 (ORO-3819-5) LECHER WIRE MICROWAVE SYSTEMS FOR FLOWING PLASMA DIAGNOSTICS. Technical Note BN-696. Cheung, Augustine Yim- Pan (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). May 1971. Contract AT(40-1)-3819. 62p. Dep. NTIS.

A Lecher wire, an open twin-line conductor, was used in flowing plasmas to provide a sensitive screen for measurements on propagating features without seriously obstructing the flow. Microwave radiation at ~9 GHz was coupled into the plasma for electron density and electron temperature measurements using the Lecher wires. The connection from X-band waveguides to Lecher wires was provided by either a fin-line transition or a tapered parallel plane transition. The fin-line connected Lecher wire was used as a component in an X-band Fabry–Perot interferometer for measuring electron densities ranging from 5×10^{10}/cm^3 to 10^{12}/cm^3. The tapered parallel plane connected Lecher wire was used as a probing element in a system which measures both the plasma electron density and electron temperature using information obtained from the change in phase, transmission, and reflection in the system during the passage of the flowing plasma. A seven-layer dielectric model was adapted for data analysis, and successful measurements were made on electron density ranging from 5×10^{10} to 9×10^{11}/cm^3 and electron temperature in the range of .5 to 10 eV. (auth)

38402 ION CYCLOTRON RESONANCE AND THE EFFECT OF INTERNAL FIELDS ON PLASMA HEATING. Springer, John Raymond. Columbus, Ohio; Ohio State Univ. (1970). 103p. University Microfilms Order No. 71-7573.

Thesis.

An investigation into plasma heating through the application of rf fields operating at the ion-cyclotron frequency was made, and a series of experiments were performed and analyses made to determine certain conditions required for efficient heating. Several coil systems were designed and used to investigate the efficiency of heating by rotating electric and revolving magnetic fields, the effect of internal fields produced by correlated motion of plasma ions, and minimum electric-field-strength requirements. A method was developed for measuring the power input to the plasma, and was used along with other diagnostic techniques in investigating these problems. (TSS) (Diss. Abstr. Int., B)

38403 MEASUREMENT OBJECTIVE IN PLASMA PHYSICS. Menkes, J. (Univ. of Colorado, Boulder). Amer. J. Phys.: 39: 664-74(Jun 1971).

The characterization of plasmas in terms of the deviations from thermodynamic equilibrium is proposed. For this characterization to be meaningful, the measurements have to be independent of the constraints on the plasma. The distinction between intensive and extensive variables and the relationship between calibration of a measuring device and the interpretation of the data in an actual experiment are brought out. Finally, the commonly used measurement techniques are examined as to their suitability to effect the characterization proposed, and the limits of applicability are pointed out. (auth)

38404 PLASMA DIAGNOSTICS OF AN rf-SPUTTERING GLOW DISCHARGE. Coburn, J. W.; Kay, Eric (IBM Research Lab., San Jose, Calif.). Appl. Phys. Lett.; 18: No. 10, 435-8(15 May 1971).

The positive ions incident on the substrate plane in a planar diode discharge system were observed with an electrostatic deflection energy analyzer and a quadrupole mass spectrometer. Several targets were rf sputtered in rare-gas discharges, and the mass spectra obtained indicate that the sputtered species, which leave the target predominantly as neutrals, are subsequently ionized in the discharge by Penning ionization rather than by electron-impact ionization or other ion–molecule reactions. (auth)

38405 ION TEMPERATURE MEASUREMENTS FOR THE PROTO–CLEO STELLARATOR USING A MULTI-GRID ELECTROSTATIC ENERGY ANALYSER. Medley, S. S.; Webb, D. R. A. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., D (London); 4: No. 5, 658-65(May 1971).

A multi-grid electrostatic energy analyzer is used to measure the ion temperature of the gun-injected plasma in the PROTO–CLEO stellarator. The ion temperature exhibits a linear variation with confining field strength, typically increasing from 5 to 30 eV over a field range of 0.5 to 3.5 kG. The electron temperature, on the other hand, is independent of confining field strength. (auth) (UK)

38406 CORRELATION BETWEEN ION AND ELECTRON PROBE CURRENTS IN A TURBULENT PLASMA FLOW. Ghosh, A. K.: Richard, C.: Johnston, T. W. (Radio Corp. of America, Ltd., Montreal). Can. J. Phys.: 49: No. 11, 1114-19(1 May 1971).

An experimental investigation for the justification of using electrostatic probes for turbulent plasma diagnostics is discussed. The object is to find how faithfully the probe current fluctuations follow the electron density fluctuations since, in general, it is a function of other parameters such as temperature, plasma potential, flow velocity, and gas pressure. The procedure adopted is to study the instantaneous correlation between probes which are close to each other operating in three different modes (single ion probe, single electron probe, and double probe). The probe currents in these three modes will all have the electron density multiplied by expressions differently dependent on other parameters. Excellent instantaneous correlation observed is a persuasive indication that the probe current fluctuation is indeed a measure of the electron density fluctuation. An instantaneous correlation between an ion probe and the floating potential of another probe shows hard diode-type characteristics, the true significance of which is not fully understood. (auth) (Canada)

38407 METHOD FOR DETERMINATION OF PLASMA DENSITY IN A COLLISIONLESS PLASMA. Dote, Toshihiko (Inst. of Physical and Chemical Research, Yamato, Japan). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku: 6: No. 4, 889-902(Oct 1970). (In Japanese).

In place of Lam's unified probe theory in a collisionless plasma, which is valid in the limit of ξ (the ratio of the probe radius to the Debye radius of the plasma) $\to \infty$, a probe theory for a finite ξ is developed. Some diagrams for determination of the plasma density from the positive ion current–voltage characteristics of the probe are also presented. Moreover, according to experiments in a mercury diffusion plasma, it is found that the theory is valid. (auth) (Japan)

38408 FRACTIONAL FRINGE HCN LASER–INTERFEROMETER FOR MEASUREMENT OF PLASMA DENSITY. Olsen, John Norman. Columbus, Ohio; Ohio State Univ. (1970). 132p. University Microfilms Order No. 71-7529.

Thesis.

An HCN laser-interferometer for plasma-density measurement with fractional fringe sensitivity was developed. The far-infrared wavelength of 337 μ is of special interest as a bridge between microwave and near-infrared sources. The plasma, Burnout V at Oak Ridge National Laboratory, is of intrinsic interest as a thermonuclear fusion research device in the 10^{12-13} cm^{-3} density range. The Burnout V device produces a turbulent, hot ion (1 to 2 keV), magnetized plasma with densities in the 10^{12-13} cm^{-3} range. Calculations show that the plasma can be described by a simple cold plasma index of refraction for the purposes of far-infrared interferometry. An electric field-driven, ion-flute instability is discussed as a model for ion heating in Burnout V. Density measurements are presented for the three modes of plasma heating, both with and without spatial resolution in two background pressure regimes. (TSS) (Diss. Abstr. Int., B)

38409 TIME AND SPATIALLY RESOLVED SPECTRA OF EXPLODING WIRES. McDermott, William Edward. Davis, Calif.; Univ. of California (1970). 165p. University Microfilms Order No. 71-7943.

Thesis.

An experiment is described that makes possible the simultaneous measurement of the edge-on intensity distribution and optical depth of a cylindrically symmetric plasma. A plasma produced by an exploding copper wire is viewed during the time period from 15 to 20 microseconds after detonation. The emission and absorption coefficients are found as a function of radius for the outer 75% of the plasma. A temperature profile is obtained from these quantities assuming local thermodynamic equilibrium. The behavior of the absorption coefficient indicated the presence of strongly-broadened atomic lines. Attributing this broadening to the Stark effect enabled the extraction of a density profile. Integration of this density profile over the cross section of the wire yielded a value for the total number of atoms per unit length within 10% of the initial value. The density profile exhibits a minimum value at the position of maximum temperature. (TSS) (Diss. Abstr. Int., B)

38410 TEMPERATURE DEPENDENCE OF Hβ EMISSION FROM HOT PLASMAS. Gould, Robert J. (Univ. of California, San Diego, La Jolla). Astrophys. Lett.; 8: No. 3, 129-31(May 1971).

The Hβ production rate was computed over the temperature range 10^4 to 10^8 K by fitting to Pengelly's calculations at the low-temperature end and assuming a temperature dependence the same as that of the radiative-capture rate to all levels with principal quantum number $n \geq 4$. The functional dependence of the rate on temperature is different at the two ends of the temperature range; at high temperatures the rate is smaller than an extrapolation from the low-temperature results. (auth)

Kinetics (General)

38411 (CONF-710607–19) ANOMALOUS RESISTIVITY IN AN R. F. CONFINED PLASMA: THEORY AND EXPERIMENT. Hofmann, F. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). 17 Jun 1971. 16p. (CN-28/B-8). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

MHD calculations are compared with measurements made on an rf-confined, high-β plasma. It is shown that the electrical resistivity in the current-carrying skin layer considerably exceeds the classical value. Several theoretical formulas for anomalous resistivity, multiplied by arbitrary scaling factors, are used in the calculations. Optimum values for the scaling factors are found by comparison with measurements. (auth)

38412 (CONF-710607–30) SPATIAL-TIME EVOLUTION OF A PLASMA SUBMITTED TO A DISCHARGE CURRENT. Mercier, C.; Soubbaramayer; Boujot, J. P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 17 Jun 1971. 19p. (In French). (CN-28/C-7). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The space–time evolution of a plasma with a Tokamak-type discharge is described in terms of a two-fluid magnetodynamic

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model, including the Maxwell equations, mass continuity, equations of motion, and energy balance. The following causes of energy loss are taken into account: thermal conduction, ionization of neutrals and reheating of generated particles, charge exchange, and radiations. A choice is allowed for the functional dependence and the amplitudes of the transport coefficients (diffusion, electric resistivity, thermal conductivity) to study the possible effects of impurities, anomalies, and instabilities. This model is the subject of a numerical and theoretical study. (auth)

38413 (CONF-710607-44) NUMERICAL AND LABORATORY EXPERIMENTS IN THE POLYTRON CONFIGURATION. Watkins, M. L.; Potter, D. E.; Kilkenny, J. D.; Haines, M. G.; Dangor, A. E. (Imperial Coll. of Science and Technology, London (England). Dept. of Physics). 17 Jun 1971. 14p. (CN-28/D-9). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A two-dimensional MHD two-fluid numerical model was constructed to simulate the plasma behavior in the r–z plane of a linear Polytron—a multi-cusped pinch device in which the plasma flows through the cusps. Of importance in this code compared to the earlier "Focus" code (a two-dimensional MHD code developed by D. E. Potter) is the inclusion of the other two components of magnetic field B_r, B_z and azimuthal velocity. With the dominance of the Hall effect, it is found that the characteristic velocity determining the mesh time step is the whistler wave velocity rather than the Alfvén speed. Present results show that the collapse of an axial current sheet to the axis is modified by the cusp field to give several interesting phenomena: firstly, Hall acceleration of the ions in the axial and azimuthal direction; secondly, asymmetric ion compressional heating and electron ohmic heating; thirdly, due to the existence of a radial component of the current density locally, there can be reversal of Hall acceleration in certain regions leading to the circulation of plasma; fourthly, there is qualitative agreement with a single-particle model that a central core of plasma appears well-defined and detached from the walls. Laser-scattering diagnostics are being employed on the laboratory toroidal experiment in order to measure the electron temperature and density, enabling direct comparison with the numerical model. Magnetic-probe measurements in the ring cusp plane show that the axial current density component is confined to the magnetic axis. From the line intensity of argon IV radiation, an axial asymmetry about the ring cusp was found and confirmed by the numerical model. Toroidal effects were also observed, namely the preferential outward drift of the plasma in the later stages of the discharge and the associated vertical shift of the plasma, which is periodic with the radial magnetic field. Typical parameters in which the above measurements were made are 3 mtorr of argon, tube bore 7 cm, major diameter 50 cm, 36 cusp coils with B_z maximum 10 kG, J_z 4 kA, $N_e \sim 10^{15}$ cm^{-3}, $T_e \sim 30$ eV. (auth)

38414 (CONF-710607-68) COLLISIONLESS RELAXATION OF AN ULTRARELATIVISTIC ELECTRON BEAM IN A PLASMA. Altyntsev, A. T.; Breizman, B. N.; Eskov, A. G.; Zolotovskii, O. A.; Korotseev, V. I.; Kurtmullaev, R. Kh.; Masalov, V. L.; Ryutov, D. D.; Semenov, V. N. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 17 Jun 1971. 26p. (In Russian). (CN-28/E-20). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Experimental investigations of the interaction of a relativistic electron beam with a plasma were carried out in a device having the following characteristics: plasma column length l = 3 m, diameter 20 cm, quasi-stationary magnetic field H = 0 to 2 kG, plasma density $n = 10^{10}$ to 10^{14} cm^{-3}. Recording of the plasma density and the selection of the point of time for switching on the beam were effected with the help of a microwave interferometer (λ = 8 mm, 3 cm, and 6 cm). The working gases were hydrogen and argon. A theory is advanced for the interaction of an ultrarelativistic electron beam with a plasma, taking into account the following effects: the Cherenkov excitement of plasma Langmuir oscillations and their reaction on the beam; nonlinear processes in which a part is played by Langmuir oscillations and, in particular, their scattering on the electrons and ions of the plasma; the destruction of the Cherenkov resonance conditions between the beam and the oscillations excited by it due to inhomogeneity of the plasma; and, finally, the effect on beam relaxation of acoustic turbulence created by an opposing stream of plasma electrons. A relaxation model was constructed in which account is taken of the change in the plasma parameters due to beam heating and the reaction of these changes on the relaxation dynamics. (auth)

38415 (CONF-710607-101) BEHAVIOUR OF A PLASMA IN A STELLARATOR, FOR THE CASE OF LARGE ELECTRON FREE-PATH LENGTHS. Bocharov, V. N.; Volosov, V. I.; Komin, A. V.; Panasyuk, V. M.; Yudin, Yu. N. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 17 Jun 1971. 25p. (In Russian). (CN-28/H-1). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Characteristics of plasma behavior in a stellarator were studied under conditions where the electron free-path length is larger than or of the order of the longitudinal wavelength of drift oscillations. The relationship between the plasma decay process (decay time, density profile, etc.) and the main parameters of the experiment (magnetic field, ratio of the currents in the helical and toroidal windings, collision frequency of the plasma radius, electron temperature, etc.) was investigated. The structure of the oscillations (wavelength, frequency and correlative dimensions) accompanying plasma decay was studied; measurements were also made of the radial plasma flows caused by these oscillations. The characteristic oscillation frequencies of the potentials, electric fields, and density of the plasma are close to the drift frequency, and their dependence on the magnetic field, electron temperature, and other parameters coincides with drift theory predictions. Experiments have shown that plasma decay is determined by drift oscillations, while the plasma decay time increases with an increase in the size of the magnetic field, the plasma dimensions, and the parameter ϵ. At a quite small value of the magnetic field, a quadratic relationship is observed between the plasma decay time and the field strength; as the field increases the relationship becomes linear, the absolute decay time being 5 to 10 times greater than the Bohm time. The results obtained may be explained quantitatively if an analysis is made of the radial plasma flows caused by azimuthal drift electric fields. This process gives the characteristic time for plasma losses $\tau_p = \gamma^{-1}(a/X_0)$, where γ is the increment in the drift-collisionless oscillations, a the plasma dimensions, and X_0 the amplitude of the radial oscillations of the plasma. The expression for τ_p coincides with the empirical formulae for that value obtained experimentally. (auth)

38416 GENERATION OF NONLINEAR SOUND WAVES IN STIMULATED MANDELSTAM–BRILLOUIN SCATTERING IN A PLASMA. Rabinovich, M. I.; Fainshtein, S. M. (Gorky Radiophysical Inst., USSR). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1696-1701(May 1971). (In Russian).

Stimulated Mandelstam–Brillouin scattering (SMBS) in a plasma permitting a quasi-hydrodynamic description is considered. Stationary processes in a layer are investigated under the assumption that sound damping is not too high. The dependence of the amplitude and shape of the generated sound pulses on intensity of the incident electromagnetic wave and their variation with layer depth are determined. The possibility of applying SMBS for plasma diagnostics is discussed. Relevant estimates for a laboratory plasma are presented. (auth)

38417 INVESTIGATION ABOUT THE THERMIC CAPACITANCE AND THE SHAPE OF NOZZLES FOR GUIDING OF HIGH CURRENT PLASMAS. Kranz, Erich (Technische Hochschule Ilmenau, Meiningen, Ger.). Beitr. Plasmaphys.; 11: No. 1, 13-21(1971). (In German).

The electrical and thermal limitations of a nozzle are calculated from electrical data of argon arcs for guiding and constricting high-current plasmas. The maximum nozzle length was determined as a function of nozzle diameter and amperage. The experimental verification of the results gives the following relation between the minimum nozzle diameter and amperage for argon arcs using the best nozzle cooling $d[cm] = 10^{-3}\ I[A]$. With superposed gas flow, values are $d[cm] = 0.5 \times 10^{-3}\ I[A]$. The attainable current density is 6×10^3 A cm^{-2} without superposed gas flow and 6×10^4 A cm^{-2} with superposed gas flow. (auth)

38418 WALL LOSSES ON SIMILAR POSITIVE COLUMNS OF NEON LOW-PRESSURE GLOW DISCHARGE. Schmidt, Martin (Zentralinstitut fuer Elektronenphysik, Greifswald, Ger.). Beitr. Plasmaphys.; 11: No. 1, 67-74(1971). (In German).

In positive columns of neon low-pressure glow discharges, ion wall current densities are measured by sampling the ions through a small hole in the wall of the discharge tube. The results are compared for different discharge conditions and agree with the predictions of the B-invariant similarity rules given by Rutscher et al. The values of the wall current densities are compared with theoretical losses. (auth)

Kinetics (Experimental)

38419 (CONF-710607-57) EXPERIMENTAL RESEARCH ON NONLINEAR EFFECTS IN THE INTERACTION OF NON-

RELATIVISTIC AND RELATIVISTIC BEAMS WITH A PLASMA. Bakai, A. S.; Berezin, A. K.; Berezina, G. P.; Bolotin, L. I.; Egorov, A. M.; Erokhin, N. S.; Zeidlits, V. P.; Ivanov, B. I.; Izmailov, A. N.; Kivshik, A. F.; Kiselev, V. A.; Kovpik, O. F.; Kornilov, E. A.; Kolyada, Yu. E.; Krivoruchko, S. M.; Kurilko, V. I.; Lutsenko, E. I.; Pedenko, N. S.; Mitin, L. A.; Moiseev, S. S.; Tolstoluzhskii, A. P.; Fainberg, Ya. B.; Shapiro, V. D.; Shevchenko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 17 Jun 1971. 39p. (In Russian). (CN-28/E-9). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

An experimental investigation was carried out of the nonlinear processes of interaction of waves with particles and of waves in plasma–beam discharges: the threshold excitation of low-frequency waves by high-frequency waves and the induced scattering of waves on the plasma electrons were established; the mechanism of plasma electron and ion heating in low-frequency and high-frequency fields was studied; also, the influence of the effect exerted by the transformation of high-frequency waves on the stabilization of low-frequency instability was investigated. It is shown that, under the given conditions, the coefficient for the transformation of high-frequency into low-frequency oscillations is anomalously high. Methods were developed for the control of low-frequency instabilities. The role was determined of various types of low-frequency oscillations in the heating of the plasma. Experimental confirmation was obtained of the theoretically predicted effect of nonlinear Landau damping in a strong magnetic field (induced scattering). The force of a Langmuir probe wave in the case under review is associated with the resonance interaction of the pulses of the main and probe waves with the plasma electrons. The increment of the buildup is in agreement with the theoretical value. An investigation was carried out of the nonlinear stage in the development of low-frequency instabilities brought about during beam–plasma interaction. Experimental determinations were made of the spectral density of the energy of the excited electric fields, space–time correlation functions, the existence of phase jumps and the dispersion ratio of excited low-frequency oscillations. The interaction of a relativistic electron beam with the plasma was studied. The beam parameters were as follows: energy, 3 MeV; current, 1 A; duration, 2.5 μs. The plasma density was 10^{12} to 10^{14} cm^{-3}. Determinations were made of the beam energy losses caused by collective interaction of the beam with the plasma. Collective interactions of charged particles with the plasma in strong electric fields (5 kV/cm) were investigated. Studies were carried out of methods of controlling instabilities (stripping and attenuation) in a linear plasma betatron with a 5 to 10 kA current at a beam energy of 200 keV. Experiments were conducted on aspects of the propagation of high-intensity electromagnetic waves (P = 1.5 to 15 MW), used for charged particle acceleration, in a plasma waveguide in a magnetic field. (auth)

38420 (CONF-710607–58) EXPERIMENTAL RESEARCH ON THE COLLISIONLESS RELAXATION OF ION STREAMS IN A PLASMA. Borisenko, A. G.; Kirichenko, G. S.; Khmaruk, V. G. (Akademii Nauk Ukrainskoi SSR, Kiev. Institut Yadernykh Issledovanii). 17 Jun 1971. 23p. (In Russian). (CN-28/E-10). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The trend in the distribution function ot a monoenergetic ion beam introduced into a plasma and the spectra of excited ion-acoustic oscillations were investigated. The experiments were carried out under conditions of a beam–plasma discharge in a longitudinal magnetic field and in a low-pressure plasma without a magnetic field over the following range of conditions: plasma concentration 10^9 to 10^{10} cm^{-3}, electron temperature 5 to 50 eV, beam current 1 to 2 mA. It was found that the effectiveness and nature of the interaction is determined by the ratio of the beam velocity V to the velocity of the nonisothermic ion sound C_s, where $C_s \sim (T_e^k/M_i)$. When $V/C_s \sim 1$, the interaction between the beam and the excited ion-acoustic oscillations leads to the establishment initially of a plateau, and subsequently to a distribution function of the beam ions with a negative derivative and the occurrence of anomalously accelerated particles. The size of the directional energy losses of the beam in the plasma under these conditions reaches tens of percent. The excitation of nonlinear ion-acoustic oscillations results in heating of the plasma ions. With an increase in the velocity of the beam ($V/C_s \gg 1$) the interaction is accompanied by preferential angular scattering of the ions on the oscillations. The excitation of ion-acoustic oscillations does not take place when the beam velocity is reduced to a value of the order of the thermal velocity of the plasma ions. The results of the experiments agree qualitatively with the conclusions to be drawn from quasi-linear theory, taking into account captured particles. An experimental investigation was carried out on the nonlinear relaxation of two ion streams of comparable density moving in the plasma. It was found that as a function of the boundary conditions, the deformation of the distribution function occurring when there is interaction between streams moving with a relative velocity $V \sim C_s$ proceeds asymmetrically with respect to their average velocity. The length of the relaxation path in a system of this kind agrees qualitatively with that obtained from the solution of nonlinear equations on a computer. (auth)

38421 (CONF-710607–59) SOME NONLINEAR PHENOMENA ASSOCIATED WITH HIGH-FREQUENCY BEAM–PLASMA INSTABILITIES. Piffl, V.; Sunka, P.; Ullschmied, J.; Jungwirth, K.; Krlin, L. (Ceskoslovenska Akademie Ved, Prague. Ustav Fyziky Plazmatu). 17 Jun 1971. 14p. (CN-28/E-11). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

High-frequency instabilities in a beam–plasma system were investigated experimentally. The measurements were performed on two experimental facilities. In one of them (the beam current $I_b \leq$ 50 mA at 5 kV) the plasma is created independently of the beam, and in the range of parameters examined, only the instability with $\omega > \omega_{ce}$ is excited. In the second facility the plasma is created by the electron beam itself (beam current up to 500 mA at 3 kV) and the process of the plasma buildup, up to the densities when $\omega_{pe} \approx \omega_{ce}$, is influenced only by the instability at the frequencies $\omega < \omega_{ce}$. The working gas is argon. In both cases the plasma is immersed in a homogeneous magnetic field ($B_0 \leq$ 800 G and 2000 G, respectively) and the number density of the plasma varies within the limits 10^9 to 10^{12} cm^{-3}. (auth)

38422 (CONF-710607–121) EXPERIMENTAL STUDY OF COLLISIONLESS SHOCK WAVES. Paul, J. W. M.; Daughney, C. C.; Holmes, L. S.; Rumsby, P. T.; Craig, A. D.; Murray, E. L.; Summers, D. D. R.; Beaulieu, J. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 9p. (CN-28/J-9). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Experiments relating to four collisionless shock problems are described. Observations are presented of the interstreaming and interaction of (a) two laser produced plasma plumes, and (b) a laser produced plasma explosion with various background plasmas. The effect of a small magnetic field is also described. These results are related to instability theory and the problem of generating high Mach-number shocks for zero or small magnetic field. The "Tarantula" z-pinch apparatus yielded new information on shock waves propagating perpendicular to a magnetic field in two régimes of Alfvén Mach number, M_A: (a) $M_A < 3$: The microturbulence within these collisionless shocks is studied by scattering light from the density fluctuations. Measurements of the frequency and wave-number spectra and the level and anisotropy of the turbulence indicate current-driven ion-wave instability and nonlinear limitation by ion-wave decay. (b) $M_A > 3$: The conditions for the formation of the characteristic double structure are measured and compared with theoretical predictions. The prediction that ions are reflected within the shock is confirmed by analyzing the fast neutrals resulting from charge exchange. In a new apparatus, called Charybdis, shock waves are produced that propagate parallel to a magnetic field. These shocks are generated by applying a fast-rising radial electric field (E ~ 100 kV/m) to the end of a column (0.5-m diameter by 1.0-m long) of highly ionized plasmas in an axial magnetic field. The development and structure of the shocks are studied by electric and magnetic probes and compared with theoretical predictions. These measurements indicate the formation of a switch-on shock at low M_A. (auth)

38423 (CONF-710607–122) EXPERIMENTAL STUDY OF COLLECTIVE DISSIPATION IN SHOCK WAVES FOR A WIDE RANGE OF PLASMA PARAMETERS. Keilhacker, M.; Kornherr, M.; Niedermeyer, H.; Steuer, K.-H.; Chodura, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 17 Jun 1971. 15p. (CN-28/J-10). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Collective dissipation in collisionless shock waves was investigated in two theta-pinch experiments. These investigations are complementary in that the plasma parameters governing the onset of certain instabilities leading to microturbulence and collective dissipation can be varied over a wide range. In the "Turbulent Heating Experiment" (coil diameter 16 cm) the shock waves propagate into an initial deuterium plasma of density $n \sim 3 \times 10^{14}$ cm^{-3} produced by a fast theta pinch. The characteristic parameters are $\beta \sim 1$, $T_e/T_i \sim 0.2$, $\omega_{pe}/\omega_{ce} \sim 100$. Quasi-

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stationary shock waves can be generated for Mach numbers M ranging from 1.5 to 5. Time-resolved light-scattering measurements (ruby and pulsed CO_2 lasers) show strong collisionless electron heating accompanied by density fluctuations that are up to 250 times the thermal value. The frequency and wave number spectra as well as the angular distribution of this turbulence are measured. The turbulence seems to originate from electron cyclotron waves driven by the diamagnetic current in the shock front. The ion heating is measured by collective scattering from thermal fluctuations. For $M > M_{crit}$ nonadiabatic ion heating is observed. In the "Minimax" device (coil diameter 43 cm), a trapezoidal magnetic field pulse (rise time 70 nsec) is generated by a Blumlein line. The uv radiation of two z pinches in xenon preionizes the working gas (H_2, D_2, or a rare gas, $n = 10^{12}$ to 5×10^{13} cm^{-3}). The characteristic parameters can be varied: $\beta \sim 10^{-2}$, $T_e/T_i = 1$ to 10, $\omega_{pe}/\omega_{ce} = 5$ to 100, $M = 1$ to 6. Fast magnetic miniature probes and the observation of satellites of forbidden lines are used to investigate electric and magnetic field fluctuations occurring in the piston region during fast compression of the plasma. The amplitude of the fluctuating electric fields is about 5 kV/cm corresponding to an energy density of about 0.5% of the thermal energy of the electrons. Coherent magnetic fluctuations near the ion plasma frequency with amplitudes up to 10 G are correlated with the electric fluctuations. The results are consistent with the assumption of an electron cyclotron drift instability. At supercritical Mach numbers a "foot" develops in the magnetic field profile. (auth)

38424 ELECTRON–ION RECOMBINATION AND DIFFUSION IN A CRYOGENIC HELIUM PLASMA. Fugol, I. Ya.; Samovarov, V. N.; Starkov, M. G. (Physical-Tech. Inst. of Low Temperatures, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1637-57(May 1971). (In Russian).

The kinetics of recombinational and diffusion destruction of the electron density n in a helium plasma is measured by the resonator technique in a broad temperature range from 293 to 10°K and in a pressure range from 1 to 30 mm Hg. The ambipolar diffusion coefficient of a diatomic He_2^+ ion measured at room temperature is $D_2P = 680$ cm$^2 \cdot$ sec$^{-1} \cdot$ mm Hg. A triatomic helium ion He_3^+ with a coefficient $D_3P = (280 \pm 15)$ cm$^2 \cdot$ sec$^{-1} \cdot$ mm Hg was observed at 100°K. The collision cross section for polyatomic helium ions colliding with atoms is estimated on the basis of these measurements. With decreasing temperature, the region of recombinational plasma destruction considerably broadens and a linear dependence of n^{-1} (t) is observed in a large range of variation of concentration. The two-body recombination coefficients α are independent of pressure and equal 5.8×10^{-8} cm$^3 \cdot$ sec^{-1} at a temperature of about 100°K and 1.3×10^{-7} cm$^3 \cdot$ sec^{-1} for a plasma cooled by liquid helium. At 10°K, electrons cool off at a very slow rate in a helium plasma. Recombination mechanisms are discussed, and it is concluded that the main contribution to such large values of α are due to collisional–radiative recombination with dissociation and also purely dissociative recombination of triatomic He_3^+ ions with electrons. (auth)

38425 DIFFUSION IN A MICROWAVE-EXCITED PLASMA. Heintz, Roger E. Syracuse, N. Y.; Syracuse Univ. (1970). 53p. University Microfilms Order No. 71-10,927.

Thesis.

The experimental investigation of diffusion in a microwave-excited plasma is reported. The plasma is contained in a microwave cavity and driven in the TM_{010} mode at approximately 8.4 GHz. The cavity is immersed in a static uniform magnetic field variable up to 3750 G. Gases used in these experiments were argon, helium, and hydrogen at pressures of .02, .16, and .65 torr. The diffusion was determined from measurements of the net power absorbed by a constant density plasma as a function of magnetic field. Instabilities were observed only in argon at a pressure of .02 torr. For stable plasmas, the power was essentially a monotonic decreasing function of the magnetic field. While some aspects of the experimental results agree with ambipolar diffusion theory, others do not. A marked difference is the strong dependence of the radial density distribution on the magnetic field. Also investigated was the decay of an afterglow helium plasma at .16 and .65 torr. The plasma was observed to decay approximately 2 to 3 times faster than predicted by ambipolar diffusion. (Diss. Abstr. Int., B)

38426 INTERACTION OF A HELIUM PLASMA WITH AN INHOMOGENEOUS TRANSVERSE MAGNETIC FIELD. Markovic, Petar D. Knoxville, Tenn.; Univ. of Tennessee (1970). 112p. University Microfilms Order No. 71-7657.

Thesis.

Phenomena associated with the interaction of a plasma bunch with a transverse inhomogeneous magnetic field was studied. A helium plasma, produced by a conical z-pinch gun, was used. The magnetic field was generated by discharging a 28.6-μf capacitor into two square coils mounted in a mirror-like configuration inside a vacuum box. The base operating pressure in the interacting region was kept at 3×10^{-6} torr between the cycles. Magnetic-probe measurements show that up to a critical value of the background magnetic field, B_c, the plasma penetrates the region occupied by the field by completely removing it. An increase in the plasma electron temperature and density is seen for $B_0 < B_c$, where B_0 is the background field. Experimental evidence shows that, for fields higher than the critical value B_c, plasma penetrates in the form of thin sheets oriented along the magnetic-field lines. The observed effects are compatible with the available theory when finite resistivity of the plasma is taken into account. (Diss. Abstr. Int.,B)

Kinetics (Theoretical)

Refer also to abstract 39334.

38427 (CONF-710607–43) NONADIABATIC IONS IN THE DISTRIBUTION FUNCTION FROM SELF-CONSISTENT CALCULATIONS OF THE PLASMA FOCUS. Potter, D. E.; Haines, M. G. (Imperial Coll. of Science and Technology, London (England)). 17 Jun 1971. 12p. (CN–28/D-8). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A three-dimensional simulation in phase space of the ions in the plasma focus demonstrated that, in some modes of operation of the experiment, the ion distribution function has two components. Most of the ions are in a quasi-thermal equilibrium, but a small component of the distribution function is accelerated to high energies. The interaction of this high-energy component with the background ions yields a high neutron emission and, in particular, gives rise to an anisotropy in the energies of the neutron emission. Previous two-dimensional magnetohydrodynamic simulations of the dense plasma focus have, in many respects, agreed quantitatively with experiment. The MHD simulations however, while describing a thermonuclear neutron emission, have not been able to account for the experimentally observed anisotropic neutron emission. The numerical experiments of a "magnetohydrodynamic focus" have shown that, at high bank energies and lower densities, the ions become collisionless in the plasma focus. This paper, therefore, reports the simulation of 20,000 ion particles that interact in the self-consistent electromagnetic field of an electron fluid. The particles have co-ordinates of radius, radial velocity, and axial velocity. The singular ions are produced by nonadiabatic motion of ions with large Larmor radius about the field-free axis of the pinch. While these ions produce an anisotropic neutron emission, they effectively remove the high-energy tail of a Maxwellian distribution and, thereby, limit a larger thermonuclear emission from the dense plasma focus. To minimize this effect, the escape of high-energy singular ions must be halted by ion–ion collisions. Hence, as the bank energy of the plasma focus is increased, the density of the plasma focus must necessarily be increased further. Thus, on the basis of the simulations reported, scaling laws of the optimized neutron yield for the plasma focus to bank energies of a megajoule were determined. Further applications of these computer simulations of nonadiabatic self-consistent ion motions include studies of the tail of the magnetosphere and reversed fields in the theta pinch. (auth)

38428 (CONF-710607–56) FLUCTUATING ELECTRIC FIELDS IN A TURBULENT PLASMA. Berezin, A. B.; Dubovoi, L. B.; Lyublin, B. V. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 17 Jun 1971. 18p. (In Russian). (CN–28/E-8). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The electric fields occurring in a plasma produced by z discharges with a rapidly alternating current were studied. The experiment was carried out in two devices: Omega-1 ($I = 1.2$ kA, $\omega = 10^7$ s^{-1}) and Omega-2 ($I_{max} = 3$ kA, $\omega = 2 \times 10^6$ s^{-1}). When a high-frequency or rapidly alternating current flowed through the plasma, a stable skin layer formed in which effective electron and ion heating occurred. The electric field strengths were determined as a function of the discharge parameters and the direction of observation from the broadening of the Balmer series lines of hydrogen. Calculations of the effective values of the electric fields on the basis of Stark broadening of the lines were performed in the quasi-stationary approximation and in an approximation based on broadening due to high-frequency fields at ion-acoustic and Langmuir frequencies. The measurements in Omega-1 showed that the fluctuating electric field grows as the axial magnetic field increases. For magnetic fields greater than 1 kG the measured electric fields are at least an order of magnitude stronger than the

electric field produced by the applied voltage. Measurements in the longitudinal and transverse directions relative to the discharge axis point to a considerable anisotropy of the turbulent fields. The longitudinal fields are at least five times weaker than the transverse ones. By measuring simultaneously the broadening of the Balmer series lines and the shift of the forbidden helium line, one can determine the dispersion characteristics of the excited electric fields and relate their appearance to the buildup of oscillations of a certain type. By making polarization measurements of the σ and π components of the contours of the Balmer series lines, earlier data on the spatial anisotropy of the fluctuating fields were refined. The degree of plasma turbulence and the effective collision frequency, computed from the electric field values obtained, are in satisfactory agreement with the theory. The fluctuating electric fields in the plasma produced by a toroidal discharge with a combined quasi-constant and high-frequency current were measured in the Toloscope device. According to the preliminary results, the electric fields in this plasma are considerably weaker than the electric fields observed in plasmas produced by straight discharges. The occurrence of electric fields is ascribed to the development of ion-acoustic instability in the skin layer of straight discharges. (auth)

38429 (CONF-710607-61) NONLINEAR THEORY OF THE INTERACTION OF RELATIVISTIC AND NONRELATIVISTIC BEAMS WITH A PLASMA. NONLINEAR THEORY OF WAVE TRANSFORMATION. Erokhin, N. S.; Kurilko, V. I.; Levin, M. B.; Lyubarskii, M. G.; Matsiborko, N. G.; Moiseev, S. S.; Onishchenko, I. N.; Tolstoluzhskii, A. P.; Fainberg, Ya. B.; Shapiro, V. D.; Shevchenko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 17 Jun 1971. 39p. (CN-28/E-13). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The excitation of a monochromatic plasma wave by an electron beam is considered. By numerical integration on a computer the maximum field amplitude induced by the beam was found, and it is shown that the capture of beam particles in the potential well created by the wave leads to oscillations in its amplitude with time. The radiation of bunches of particles captured by the wave leads to the excitation in the oscillation spectrum of harmonics displaced in frequency relative to the fundamental harmonic by a value of the order of the frequency of the phase oscillations of an electron in the field of the fundamental wave. This "satellite" instability develops to a considerable extent when relaxation of the initial "monoenergetic" beam occurs in the plasma and leads to a dip in the plateau of the distribution function and to the appearance of accelerated particles in the beam. A computer was used to investigate the interaction of two signals of final amplitude in the plasma–beam system. The possibility is shown of controlling beam instabilities by means of prior modulation of the beam. Attention is devoted to nonlinear stationary waves in relativistic electron beams of the E-layer type. It is shown that attenuation of the Coulomb repulsion forces due to the rotational motion of the electrons results in a considerable increase in the field amplitude. Nonlinear solutions of the "isolated"-wave type were found. A nonlinear theory was developed for the Cherenkov excitation of regular oscillations by a pulsed relativistic monoenergetic beam, taking into account the effect of the buildup of energy of the oscillations excited in the plasma. It is shown that the reaction of the field to the motion of the beam particles stabilizes the increase in the field amplitude; calculations were made of the nonlinear increment, the maximum amplitude of the field, and the distribution function of the beam leaving the plasma as a function of the injection energy. Some special features of wave transformation in an inhomogeneous plasma in the presence of a beam are explained. The excitation of the harmonics of a longitudinal and a transverse wave as a result of the echo effect in an inhomogeneous plasma and also as a result of increasing the electric field in the region of the hybrid resonances of the plasma is discussed. The competing effects of parametric instability and wave transformation in an inhomogeneous plasma are investigated. The question of the transformation of stationary nonlinear waves in the plasma is discussed. (auth)

38430 (CONF-710607-65) COMPUTER SIMULATION OF ANOMALOUS RESISTANCE. Biskamp, D.; Chodura, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 17 Jun 1971. 9p. (CN-28/E-17). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The current-driven ion-sound instability is investigated by two-dimensional computer experiments for three different cases: (1) $\mathbf{j} \perp \mathbf{B}_0$ ($\mathbf{j}$ = current density, $\mathbf{B}_0$ = static magnetic field), (2) $\mathbf{B}_0 = 0$, and (3) $\mathbf{j} \parallel \mathbf{B}_0$. In all cases the ion-sound instability is stabilized by ion trapping. For $\mathbf{B}_0 = 0$ or $\mathbf{B}_0 \parallel \mathbf{j}$, quasi-linear effects on the electron distribution function are present; they reduce the growth rate, especially of modes in the current direction, but do not quench it. No noticeable difference is found between cases 2 and 3, in agreement with results of real experiments. While in case 1 the numerical value of ν_{eff} is consistent with measurements on shock experiments, there seems to be a discrepancy for the other two cases, which originates from the relatively large portion of runaway electrons. This effect is believed to be due to the two-dimensional geometry used and is expected to be much smaller in a fully three-dimensional system. (auth)

38431 (CONF-710607-67) RESULTS OF RECENT RESEARCH ON THE ANOMALOUS RESISTANCE OF A PLASMA. Vekshtein, G. E.; Kurtmullaev, R. Kh.; Ryutov, D. D. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 17 Jun 1971. 24p. (In Russian). (CN-28/E-19). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The evolution with time of the distribution functions of charged particles in a homogeneous plasma established in an external electric field parallel to the magnetic field was investigated. It was found that if the energy lifetime of the plasma particles is high in relation to the duration of the experiment, and there are no two-body collisions, then some considerable time after the application of the electric field the distribution functions begin to change in a self-simulating way, during which all the velocities increase linearly with time. It is shown that the part played by nonlinear processes in a self-simulating regime is not substantial. A formal investigation was carried out of quasi-linear equations written in self-simulating variables, from which it follows that in a self-simulating régime the current velocity of the electrons $\bar{v}$ changes basically in the same way as when there is free acceleration: $\bar{v} = \alpha\,(lEt/m)$, where α is a numerical coefficient that is smaller than, but of the order of, unity. The effect of Coulomb collisions is assessed, and the finiteness of the energy lifetime of the particles was found. The possibility is examined of extending the theory postulated to the case of electrode discharges. A separate investigation was made for the case where the current is perpendicular to the external magnetic field. It is shown that, in this situation, "runaway" of the electrons disappears and the ratio of their current velocity to the thermal velocity becomes much less than unity. An analysis is made of experimental data, obtained in various electron current excitation systems, on anomalous dissipation in collisionless plasma. The dissipation mechanism and plasma resistance laws were studied in greatest detail in the case of an electron current flowing across the magnetic field created during the generation of powerful shock waves in dilute plasma. Research methods, with a resolution of $\sim 10^{-2}$ cm, make it possible to establish in the transition region of a shock wave the distribution of the main parameters of the process (magnetic field, electric potential and thermal and current velocities of the electrons) and also a detailed picture of the development of the plasma resistance. In addition, the electromagnetic fluctuations and the ion temperature are simultaneously recorded. The results obtained show that heating of the plasma occurs mainly in the region of the front, where the ratio of the current velocity of the electrons to the thermal velocity is less than unity; this ratio maintains an approximately constant value, close to $\sqrt{(M_e/M)}$. The plasma resistance in this region undergoes a jump several orders of magnitude greater than that corresponding to the Coulomb value at the local electron temperature value. (auth)

38432 (EUR-CEA-FC-578) STATISTICAL STUDY OF A HELIUM PLASMA OUTSIDE LOCAL THERMODYNAMIC EQUILIBRIUM. Emard, Francoise (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan 1971. 142p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences.

Nonlocal thermodynamic equilibrium plasmas can be described on the basis of a statistical model of elementary processes. This model is developed here for a helium plasma in which the structure of the helium atom is accounted for. A detailed review of the electronic, atomic, and radiative processes that are susceptible to modify the composition of the plasma is given. The rate coefficients are established on the basis of these reaction processes, which permit the calculation of the population densities of all levels, the degree of ionization, and the collisional–radiative recombination and ionization coefficients. Assuming a Maxwellian velocity distribution, analytical expressions for the rate coefficients could be established. The population densities were expressed as a function of two dimensionless coefficients, $r_1^{(0)}$ and

$r_i^{(1)}$, and of the particle density in the ground state. The numerical values of the dimensionless coefficients are presented graphically as a function of the principal quantum number for different cases of radiative absorption, electron density, and temperature. Deviations from local thermodynamic equilibrium remain large in the case of strong resonance absorption at relatively low electron densities. The role played by atomic collisions is studied. Their influence cannot be neglected when the electron density is 10^3 (or 10^4) times smaller than the atom density. The collisional radiative recombination and ionization coefficients are presented graphically as a function of the electron density with the temperature as a parameter. Their values are compared with those for a hydrogen plasma. Deviations appear at high electron temperatures. When $n_e/n_{atom} < 10^3$ or 10^4, atomic collisions cannot generally be neglected in the calculation of the recombination and ionization coefficients. The limit of application of the present model is discussed. (France)

38433 KINETIC THEORY OF A PLASMA IN A SMALL ELECTRIC FIELD. Bateman, Russell Glenn Jr. Princeton, N. J.; Princeton Univ. (1970). 123p. University Microfilms Order No. 71-1580.

Thesis.

New methods are developed for the derivation of plasma kinetic equations. Also, a solution is found for the distribution of runaway electrons from a plasma immersed in a constant, uniform electric field smaller than the Dreicer runaway field. No magnetic fields are considered. The derivation of kinetic equations proceeds from a Klimontovich formalism modified so that spurious self-field effects are omitted. The equations of motion are formally equivalent to the Vlasov equation. By separating dispersion effects from the source terms, an efficient iteration method is developed to evaluate the nonlinear terms. A separate method is developed, using multiple time scaling, for the case when the background state of the plasma is a slowly varying function of time. It is found that there are as many time scales as there are independent modes of the Vlasov equation. The differential ratio between each slow and fast time scale is itself a slowly varying function of time (synchronization of time scales); each synchronization is determined by the eigenvalue of that mode. Hence, for the success of the multiple-time-scaling technique, the solution must be expanded in normal modes. The modes themselves are represented by a modification of the Case–Van Kampen normal modes. (TSS) (Diss. Abstr. Int., B)

38434 METAL–NONMETAL TRANSITION AND POSSIBLE PHASE TRANSITION IN A DENSE (STRONGLY IMPERFECT) PLASMA. Norman, G. E. (Inst. of High Temperature, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1686-95(May 1971). (In Russian).

Approximate formulas are proposed for the free energy of a three- or two-component plasma. The formulas are valid for densities ranging from gas to metallic values. The corresponding equations of state and ionization equilibrium are analyzed. The model proposed predicts three phase transitions: a vapor–liquid, metal–nonmetal (metallization), and plasma. It is shown that with increase of temperature the nonmetal–metal transition changes into a plasma phase transition. Within the framework of the model under consideration, the nonmetal–metal transition is found to be a phase transition of the first kind, resembling a phase transition of the second kind. The corresponding critical and triple points are discussed. (auth)

38435 COLLISION INTEGRAL FOR A CLASSICAL PLASMA. Alyamovskii, V. N. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1672-85(May 1971). (In Russian).

The Bogolyubov–Born–Green–Yvon–Kirkwood equations for a classical nonequilibrium gas are reduced to a set of integral (with respect to a certain auxiliary "time") equations for the correlation functions. It is assumed in these equations that the problems of motion of two, three, etc., particles are solved. This form of the equation is convenient in the case of a long-range interaction potential (in particular a Coulomb potential); thus, it permits one to readily take into account "screening" of interactions at large distances, when the interaction is described exactly at short distances for which the potential may be arbitrarily strong. The spatially homogeneous case is considered. The results for pair correlations are employed for deriving the kinetic equation for an electron plasma in the lower approximation with respect to density. The collision integral is free of all types of divergences. Its Fokker–Planck part, which contains the "dynamic polarization" effects of the plasma, is similar to the well-known Balescu-Lenard–Guernsey integral, but in contrast to the latter, is finite. (auth)

38436 FINE STRUCTURE OF SHOCK WAVES IN A PLASMA AND THE MECHANISM OF ION-ACOUSTIC TURBULENCE SATURATION. Eselevich, V. G.; Es'kov, A. G.; Kurtmullaev, R. Kh.; Malyutin, A. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1658-71(May 1971). (In Russian).

The fine structure of shock waves in a collisionless plasma at $M < 2.5$ was studied. Distribution of the magnetic field was measured by means of a special probe with a resolution up to 0.1 mm. The distribution of other quantities within the front was determined from the H(x) profile by means of MHD equations. Based on the experimental data, it is suggested that for an initially isothermal plasma, ion-acoustic instability develops after preliminary electron heating, either at the expense of Joule dissipation in a classical resistor or at the expense of beam instability. The distribution of quantities in the turbulent region of the front is in accordance with the assumption of a linear (resonance) mechanism of phonon interaction with hot ions. On the other hand, the experimental value of parameter A, characterizing the nonlinear interaction, differs from the predicted value by at least one order of magnitude. (auth)

38437 DIFFUSION–COMBINATION KINETICS OF COLUMNAR IONIZATION IN GASES. Orvis, Douglas Dean. Gainesville, Fla.; Univ. of Florida (1970). 294p. University Microfilms Order No. 71-13,444.

Thesis.

The dynamic behavior of a small cylindrical volume of an ionized gas is studied theoretically with the aid of numerical computations. The study is oriented toward establishing the feasibility and efficiency of techniques for generating a plasma in a gas-cooled nuclear reactor. A basis for investigation is the potential utilization of the products of the $^3He(n,p)^3H$ reaction to ionize a reactor coolant gas, which contains the isotope ^3He. However, ionization by fission fragments is also considered. One goal of the study is to determine the effective rate of diffusion for the column particles and to infer the time required for a number of separate columns to merge into a homogeneous ionized gas. Unless such homogeneity is achieved, the maximum conductivity cannot be realized in the ionized gas. An attendant problem of the prolonged concentration of ionization in columns is enhanced recombination. Thus, both the homogenization and columnar recombination problem are considered. (TSS) (Diss. Abstr. Int., B)

38438 RADIAL CHANGES OF ELECTRON ENERGY DISTRIBUTION FUNCTION IN PLASMA OF POSITIVE COLUMN OF ELECTRIC DISCHARGES. Herrmann, D.; Rutscher, A.; Pfau, S. (Ernst-Moritz-Arndt Univ., Greifswald, Ger.). Beitr. Plasmaphys.; 11: No. 1, 75-84(1971). (In German).

In the low-current positive column, measurements of the electron energy distribution function show considerable changes in radial direction. At any point of the positive column of the Ne discharge under investigation, it is possible to approximate the energy distribution function by the Druyvesteyn standard form. For the case of standard energy distribution functions, a theory of positive column is developed that takes into account radial changes of electron temperature. Formulas for the calculation of radial behavior of electron temperature, space potential, and radial electric field strength are given and compared with experimental results. (auth)

38439 VELOCITY DISTRIBUTION OF IONS IN THE FREE-FALL COLUMN. Valentini, H.-B. (Zentralinstitut fuer Elektronenphysik, Jena, Ger.). Beitr. Plasmaphys.; 11: No. 1, 93-8 (1971). (In German).

The velocity distribution of the ions in the positive column of the free-fall type discharge is derived by means of the method of characteristics from the collisionless Boltzmann equation extended by a source term in plane and cylindrical geometries. A homogeneous axial magnetic field and the initial distribution of ion velocities are taken into account. The formula of Tonks and Langmuir for ion density is reproduced in case of vanishing initial velocity of the ions and vanishing magnetic field. (auth)

38440 DIFFUSION AND THERMALIZATION OF AN ELECTRON CLOUD INJECTED INTO AN AFTERGLOW PLASMA. Van Andel, H. W. H. (Univ. of Saskatchewan, Saskatoon). Can. J. Phys.; 49: 1124-36(1 May 1971).

The steady-state distribution function for a suprathermal electron cloud injected into a cylindrical plasma is found as a function of position and velocity by solving the Boltzmann equation numerically in the Fokker–Planck approximation with an added term taking into account electron–neutral collisions. The injection is assumed to take place at one end of the cylinder, and an axial magnetic field is assumed present. A number of representative solutions are given for various choices of the parameters of the problem. (auth) (Canada)

38441 HAMILTONIAN FORMALISM FOR HYDRODYNAMIC PLASMA MODELS. Zakharov, V. E. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1714-26(May 1971). (In Russian).

The canonical variables for a hydrodynamic description of a plasma are described. They are used for obtaining simple formulas for the matrix elements of wave interaction in a plasma in the presence or absence of a magnetic field. Exact relations between increments of decay instability and kernels of the kinetic equations are found. Conditions of applicability of the kinetic equations for narrow wave packets in k-space are derived. (auth)

38442 FORMATION OF CURRENT SHEETS IN A PLASMA WITH A FROZEN-IN STRONG MAGNETIC FIELD. Syrovatskii, S. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1727-41(May 1971). (In Russian).

The conditions for appearance of current (neutral) sheets during slow movements of a plasma with a frozen-in strong magnetic field are investigated. It is shown that a necessary condition for appearance of a current sheet in the two-dimensional case is the presence of a zero magnetic field. The field structure in the vicinity of the current sheet is investigated, and a method is suggested for determination of the field satisfying prescribed boundary conditions. It is shown that, in the general case, forward and back currents exist in the current sheet. It is shown that, under special conditions, when the total current in the layer is matched in a certain way with an external field, there are no back currents and the field structure corresponds to that for self-similar solutions. (auth)

38443 NONLINEAR THEORY OF MODULATED RELATIVISTIC ELECTRON BEAM INTERACTIONS WITH PLASMA. Krasovitskii, V. B. (All-Union Research Inst. for Design and Construction of Electrical Devices, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 13: 1902-3(1970). (In Russian).

The energy of plasma waves excited by an electron beam in a plasma increases with increasing beam energy. It is of interest to estimate the energy imparted by relativistic electrons to a plasma. Electron bundles at a distance l from each other move at an initial velocity v_0 through a plasma. The size of the bundle is small compared to the distance between bundles. Equations describing the electric field interactions are written, and a solution for electric field strength is sought by taking into account the spacial periodicity of the system and momentum conservation. An expression is obtained for the maximum density of the energy of the plasma wave excited by the electron beam, and the characteristic time of the process is also given. (TTT).

38444 PLASMA PHYSICS. Birdsall, Charles K. (Univ. of California, Berkeley); Dawson, John M. pp 247-310 of Computers and Their Role in the Physical Sciences. /Fernbach, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

An introduction to plasmas is given along with some reasons for plasma simulation and a brief outline of many-body simulation. The use of one-dimensional models for plasma simulation is described. Results pertinent to laboratory experiments as obtained from two-dimensional models are discussed. (M.O.W.)

Production

38445 (CEA-R-4148) LASER-SOLID DEUTERIUM INTERACTION: NUMERICAL STUDY. Floux, Francis; Billebize, Andre (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Feb 1971. 75p. (In French). Dep. NTIS (U. S. Sales Only).

After a recall of the problem and the different theoretical approaches already attempted, a computer code was developed in order to give an account of the experimental results. Comparisons between numerical and experimental data were successfully achieved. (auth) (France)

38446 (CONF-710607-9) PLASMA PRODUCTION AND HEATING IN THE SUPERCONDUCTING LEVITRON. Anderson, O. A.; Birdsall, D. H.; Hartman, C. W.; Hooper, E. B. Jr.; Munger, R. H.; Taylor, C. E. (California Univ., Livermore. Lawrence Radiation Lab.). 27 May 1971. 19p. (CN-28/A-8; UCRL-72886). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Plasma production and heating in the Superconducting Levitron are described. The device has a floating superconducting ring with 40-cm major radius and 5-cm minor radius, which carries up to 600-kA current. Toroidal field is provided by a current of up to 1 MA. Six poloidal field coils are used to shape the magnetic surfaces to obtain field configurations with strong shear and with minimum average B, a local minimum |B| well, or minimum $\partial B/\partial s$ ($\delta B/B \lesssim 0.005$ to 0.05). Large area surfaces at liquid-helium temperature, which are not directly exposed to the plasma, provide ultra-high vacuum. Methods of production and heating of dense plasma with appreciable β were studied using a classical diffusion and thermal conduction model which includes trapped particle effects. Computations were made both for heating by an initial hot electron plasma and for energetic neutral injection. The latter technique yields $n \approx 10^{13}$ cm^{-3}, $T_e \approx T_i \approx 0.3$ to 0.8 keV with existing sources (200 mA equivalent current at 2 keV). Production and heating by energetic electrons proceeds in two steps: first, a hot electron plasma with $n \approx 10^{11}$ to 10^{13} cm^{-3}, $T_{e,hot} \approx 100$ to 500 keV is established by electron cyclotron resonance heating (ECRH); second, dense plasma is formed by injection of a short pulse (50 μs) of neutral gas. The inherent cutoff limit of direct ECRH is thereby overcome. Numerical computations of the subsequent in situ heating by energetic electrons predict $T_i = 0.14$ to 2.0 keV, $n = 5 \times 10^{13}$ to 10^{14} cm^{-3} for $B_{poloidal} = 1.5$ to 6 kG. Thus heating and ion temperatures comparable to or greater than obtained in the Tokamak T3 device are predicted. This technique allows scaling to ignition temperature for a D–T plasma using available microwave power sources and a somewhat larger device. Results of experimental studies of plasma heating and confinement using this ECRH technique in the Superconducting Levitron are presented. (auth)

38447 (CONF-710607-45) EVALUATION OF THE POSSIBILITIES OF USING A POWERFUL BEAM OF RELATIVISTIC ELECTRONS FOR THERMONUCLEAR FUSION. Babykin, M. V.; Zavoiskii, E. K.; Ivanov, A. A.; Rudakov, L. I. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 16p. (In Russian). (CN-28/D-10). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

For reducing the amount of energy and the beam strength required to initiate a thermonuclear reaction, it is proposed to heat the plasma in a shell of heavy material hindering rapid expansion, as a result of which the critical energy can be reduced to 10^5 J and the critical power to 10^{14} W. Contrary to what applies in the case of the laser method of heating, this is possible thanks to the fairly high penetrating power of relativistic electrons and the low thermal conductivity of the heated plasma at the wall due to the presence of the magnetic field created by the beam. For focusing of the beam, it is proposed to make use of the magnetic field of the beam formed as a result of the partial dissipation of the reverse current in the plasma. As it is frozen in the plasma, the magnetic field confers macroscopic stability on the beam. Calculations show that plasma having the density of a solid deuterium–tritium mixture can be heated by means of the ohmic dissipation of the reverse current to a temperature of 0.5 to 1 keV. Heating of the plasma to thermonuclear temperature by the beam can be accomplished by means of the co-operative effects. Theoretical analysis of the instability of the relativistic electron beam yields the following expression for the linear stopping power: $L = \lambda_c(\epsilon)\,\bar{\vartheta}^2\,\epsilon/mc^2\,(T_e/mc^2)^2$, where $\lambda_c(\epsilon)$ is the Coulomb path length of a relativistic electron of energy ϵ, $\bar{\vartheta}$ is the mean thermal angular scatter of the beam particle velocities, and T_e is the plasma temperature. (auth)

38448 (CONF-710607-46) INVESTIGATION OF LASER PRODUCED PLASMAS IN THE keV TEMPERATURE RANGE. Buechl, K.; Eidmann, K.; Mulser, P.; Salzmann, H.; Sigel, R.; Witkowski, S. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 17 Jun 1971. 10p. (CN-28/D-11). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Experimental and theoretical investigations of the problems associated with plasma production by laser radiation of very high intensity are reported. In the experiment, nanosecond and picosecond laser pulses were focused onto plane targets of solid hydrogen and deuterium. Reflection measurements of the laser light were performed. The electron temperature of the plasma was determined from soft x-ray-continuum intensity measurements. The spatial distribution of the ions in the expanding plasma, their kinetic energy, and their total number were determined by a set of charge-collecting probes. Neutron production in the plasma was measured with two fast scintillation detectors. The experimental results are compared with numerical calculations, which describe the gasdynamic behavior of laser-heated solid deuterium with allowance for $T_e \neq T_i$ and including the effect of heat conduction. (auth)

38449 (CONF-710607-47) APPLICATION OF LASER-PRODUCED DENSE PLASMAS TO CONTROLLED FUSION.

XUM

Bobin, Jean-Louis; Floux, Francis; Tonon, Gianfranco (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). 17 Jun 1971. 29p. (In French). (CN-28/D-12). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The observation of neutron emission by a deuterium plasma produced from the solid by a powerful laser (5 to 15 GW) has caused renewed interest in this type of experiment. Of course, the conditions required to obtain a favorable energy balance (in the Lawson sense) by the radiative deflagration mechanism, say for the D–T mixture cannot all be reached as yet. However, presently available fluxes applied to a target are barely an order of magnitude less than the required figures. A neodymium-glass laser (100 J, 3 ns) was used with the beam focused on a solid target. The temperatures measured from the emitted x radiation exceed 1 keV. Neutron emission exceeds 10^4 per shot. Interferometric arrangements are used to trace the plasma density profile; the exposure time is 1 ns. Using an arrangement consisting of four identical circuits, one can analyze the interaction between the radioactive deflagration waves. A second Nd glass laser (200 J, 30 ns) is used to ionize and heat a granule of deuterium (10^{17} particles) at the center of a magnetic mirror configuration (fields between 300 kG and 1 MG). The plasma confinement due to the field and the diffusion of the field in the plasma are revealed by an interferometric method, and the results are correlated with temperature measurements. Finally, a molecular laser (130 J, 1 μs) focused on a solid target produces a plasma whose density profile is obtained by interferometry. (auth)

38450 (CONF-710607–48) USE OF LONG-WAVELENGTH, HIGH-POWERED LASERS FOR CONTROLLED THERMONUCLEAR FUSION. Dawson, J. M.; Hertzberg, A.; Kidder, R. E.; Vlasses, G. C.; Ahlstrom, H. G.; Steinhauer, L. C. (Princeton Univ., N. J. Plasma Physics Lab.). 17 Jun 1971. 14p. (CN-28/D-13). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The possibilities of applying relatively long-wavelength lasers to the problems of obtaining controlled thermonuclear reactions are discussed. In particular, the very attractive possibilities opened up by the recent development of high-powered, high-efficiency 10.6-μm N_2–CO_2 lasers are examined. These lasers can effectively heat plasmas in the density range of 10^{17} to 10^{19} particles/cm^3 to thermonuclear temperatures. Absorption lengths for 10-μm radiation range from a few tens of centimeters to a few kilometers, depending on density and temperature; calculations show that the laser beam will be self-focusing and thus confined to the plasma. Such plasmas can be confined by available magnetic fields; for the lower densities, fields of 200 to 300 kG are required, while at the higher densities, fields of 2 to 3 MG are needed. A number of reactor possibilities are considered. The simplest is a straight device operated in a pulsed mode, similar to the θ-pinch configurations considered by Ribe. However, the laser method has the advantage that the magnetic field is not used to produce and heat the plasma. The coils can thus be designed for optimum production of the field with respect to field strength, magnetic energy required, and energy dissipation in the coils. The size of such a device depends on the strength of the magnetic field that can be used and on one's ability to inhibit plasma and heat loss from the ends. For fields of 300 kG, it appears that a working reactor of roughly 500 m is possible; for higher fields shorter devices will suffice, with the length scaling like $1/B^2$. Calculations of the parameters for such devices are given. Small experiments, using available pulsed high-field magnetics and CO_2 lasers, should be able to answer many of the questions related to building such a device. They should also be able to provide hot plasma in a number of different confinement configurations for conducting important experiments. These might include wave propagation, instability, and plasma confinement studies in finite, but adjustable-β, plasmas. (auth)

38451 (CONF-710607–98) PLASMA PRODUCTION BY NEUTRAL BEAM INJECTION IN MIRROR SYSTEMS. Berkner, K. H.; Cooper III, W. S.; Damm, C. C.; Ehlers, K. W.; Futch, A. H.; Hamilton, G. W.; Osher, J. E.; Pyle, R. V. (California Univ., Berkeley. Lawrence Radiation Lab. California Univ., Livermore. Lawrence Radiation Lab.). 11 May 1971. 18p. (CN-28/G-11; UCRL-72880). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Injection of energetic neutral atoms is the most promising method so far proposed for maintaining a fusion plasma, especially in mirror systems. Neutral injection studies at LRL are focused on two questions: (1) Whether a fusion-density plasma can be produced by buildup from low levels using neutral beams; and (2) whether a high-density plasma, however created, can be maintained by neutral injection. The Baseball II experiment attacks the first question by means of a programmed buildup. The plasma temperature and charge-exchange loss rate can be specified in relation to the density for each point in the buildup so that ion–ion Coulomb collisions will always be effective in broadening the trapped-ion distribution in both real and velocity space, thus minimizing the probability of microinstability. Scattering can be realized at a density low enough to insure initial stability by starting the buildup sequence at low energy (~1 keV). A series of numerical Fokker–Planck calculations show the degree of collisional broadening that can be expected in the presence of charge-exchange losses. A theoretical estimate of stability against electrostatic modes is made for these calculated distributions. Detailed estimates of plasma accumulation were made for achievement of the 1-keV starting point in the buildup sequence. These include the effects of cascading and Lorentz ionization of excited atoms and collisional ionization of atoms in all levels. At operating vacua (~10^{-9} torr), an injected deuterium atom beam intensity of ~35 equivalent mA is necessary to achieve the desired density. A steady-state 1-A, 1-kV source is described that uses extraction from multiple apertures to deliver the required neutral beam current within the required (±1.4°) solid angle. The second question, which is perhaps even more basic, can be answered most readily in the 2X II experiment, where a high-density plasma is created by pulsed methods. The key requirement for this test is an intense pulsed neutral beam. To this end the design of an ion source to produce a 10-A, 30-msec pulsed beam of 20-keV deuterium atoms is described. The source utilizes extraction electrodes based on computed ion trajectories and a special expanded-arc plasma. (auth)

38452 (CONF-710607–139) CYLINDRICAL PLASMA SOURCES WITH DENSITIES HIGH ABOVE CRITICAL DENSITY EXCITED BY AN RF HELIX WITH AND WITHOUT MAGNETIC FIELD. Aubert, A. E.; Messiaen, A. M.; Vandenplas, P. E. (Ecole Royale Militaire, Brussels (Belgium). Laboratoire de Physique des Plasmas). 17 Jun 1971. 16p. (CN-28/L-3). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

It is shown that the density characteristics of plasmas created by an rf helix are essentially determined by the low-power resonance features of the bounded system, which is constituted by the plasma column and the surrounding helix of finite axial length. The rf power absorbed by the system is calculated, using the theoretical model of a cold electron–ion collisional plasma. Whether a magnetic field is present or not, plasma densities high above critical density are obtained, in agreement with the general philosophy previously developed. For each azimuthal n-mode present, the appropriate boundary conditions select discrete values of $k_\perp$ (which is a function of $k_\parallel$, ω_{pe}^2/ω^2 and ω_{ce}/ω) on the dispersion curve of the infinite plasma. Experiments already performed support the theoretical predictions. When no steady magnetic field is present, very detailed comparison with experiments was performed and shows good agreement. (auth)

38453 (SC-DC–713998) LIGHTNING AND BALL LIGHTNING: FRONTIERS FOR RESEARCH. Cooper, J. A. (Sandia Labs., Albuquerque, N. Mex.). 10 May 1971. 17p. Dep. NTIS.

During the past few years, interest in lightning and ball lightning has increased dramatically. Information about these phenomena affects or might affect various scientific areas including safety, weapons strategy, magnetohydrodynamics, and meteorology. Studies of lightning and ball lightning are made difficult by the relative rarity and unpredictable locations of the events. However, there is a strong possibility that triggering mechanisms might be employed in making these phenomena more accessible to researchers. (auth)

38454 PRODUCTION OF A HIGH TEMPERATURE DENSE PLASMA BY LASER HEATING OF A SPECIAL GAS TARGET. Pashinin, P. P.; Prokhorov, A. M. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1630-6(May 1971). (In Russian).

It is shown that in order to obtain a positive energy yield (with respect to laser energy) in thermonuclear synthesis of a deuterium and tritium mixture, a laser pulse of ~10^{-7} sec duration and 3×10^5 J energy must be employed. (auth)

38455 SELF-SIMILAR PROBLEM IN A HIGH-CURRENT DISCHARGE IN PLASMA. Volosevich, P. P.; Kurdyumov, S. P.; Popov, Yu. P.; Samarskii, A. A. Zh. Vychisl. Mat. i Mat. Fiz.; 10: 1447-57(Nov-Dec 1970). (In Russian).

Studies were made of self-similar problems in which the plasma mass and energy during discharge remained constant. The solution for the problem was found for a high-magnitude heat-conductance factor. It was also found that, at high temperatures, a T-layer existed under certain self-similar conditions. The effect of thermal

conductivity on the structure was established. The analysis of self-similar solutions was supplemented by numerical calculations of the magnetohydrodynamic equation system for self-similar and nearly self-similar regions. (R.V.J.)

Stability

Refer also to abstract 38332.

38456 (CONF-710607-15) DECAY OF THE LONGITUDINAL CURRENT IN TOROIDAL SCREW PINCHES. van der Laan, P. C. T.; Schuurman, W.; Zwart, J. W. A.; Goedbloed, J. P. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). 17 Jun 1971. 6p. (CN-28/B-4). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

In toroidal screw-pinch experiments in Garching and in Jutphaas, the longitudinal plasma current is observed to decay rapidly, leading to a loss of equilibrium or to instability. A number of causes for this decay are listed. The problem of the matching of a decaying pinch to the external circuits is discussed. External losses in the z-circuit give rise to currents in the plasma near the wall and, thereby, to an enhanced decay of the net longitudinal plasma current. Losses in the θ-circuit, however, tend to increase the longitudinal current. Also, the volume currents flowing in a combined pinch lead to a transfer of energy from one field component to the other; calculations are given for a uniform-pitch screw pinch. A toroidal screw pinch will oscillate around its eccentric equilibrium position. The oscillation may force field lines into the wall and thereby decrease the plasma current. This effect diminishes when the external inductances in the z-circuit are small. (auth)

38457 (CONF-710607-16) EXPERIMENTAL AND THEORETICAL STUDIES OF A HIGH-BETA TOROIDAL PINCH. Bodin, H. A. B.; Butt, E. P.; Crow, J. E.; Irons, F. E.; Junker, J.; Newton, A. A.; Robinson, D. C. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 23p. (CN-28/B-5). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Observations on various axisymmetric pinch systems operating above the Kruskal–Shafranov limit are in broad agreement with predictions. The experiment has five capacitor banks (2 MJ in all) that can be programmed in any sequence. Longitudinal currents and fields (B_z) up to 250 kA and 12 kG were used, with risetimes about 10 μsec. The quartz torus, major diameter 2 m and bore 12 cm, was filled with deuterium between 10 and 50 mtorr pressure. Theoretically, unless the pressure gradient is positive, a pitch (rB_z/B_θ) minimum is sufficient for instability. Stability is possible with total β up to 0.3 to 0.4 when the external B_z reverses. The inclusion of compressibility increases instability growth rates, and three characteristic eigenfunctions are computed, two of which are identified in the experiment. Estimates show energy losses that can be neglected for power inputs of $\gtrsim$25 eV/particle/μsec, obtainable by compression, can become important at power inputs typical of resistive heating. In screw pinches, temperatures up to 200 eV are obtained in the central core, which can remain grossly stable for 20 μsec. The outer regions where most of the axial current flows are relatively cold, with a resistivity temperature of 5 eV, and always show radial magnetic field fluctuations. Stabilized z-pinches have resistivity and pressure-balance temperatures about 10 eV with β_θ = 0.3. In well-compressed plasmas, a stable phase of up to 15 μsec precedes a nonlocalized pressure-driven instability that appears when the pressure gradient near the axis changes from positive to negative. Weakly compressed pinches become unstable in $\gtrsim$1 μsec to a localized mode expected from an outer pitch minimum. Applying reversed external B_z to weakly compressed pinches increases the stable time from $\gtrsim$1 μsec to 6 or 7 μsec, while, with well-compressed pinches, the reversed field configuration lasts up to 15 μsec, being limited by the same pressure-driven mode as before. (auth)

38458 (CONF-710607-17) EXPERIMENTS ON A TOROIDAL SCREW PINCH WITH VARIOUS FIELD PROGRAMMING. Zwicker, H.; Wilhelm, R.; Krause, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 17 Jun 1971. 12p. (CN-28/B-6). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

In the toroidal screw pinch ISAR IV (large diameter 60 cm, aspect ratio 5, max. storage, energy 140 kJ) attempts were made to get an improved stability of the plasma by different kinds of field programming. The best results were obtained with positive trapped B_z fields and simultaneous switching of main B_z field and I_z current. In this case the dense plasma column ($n_e \approx 2$ to 3×10^{16}, kT $\approx$ 50 to 100 eV, $\beta \approx$ 15 to 20%) is surrounded by a force-free plasma ($\beta \sim 1\%$) with weak shear and it behaves stably for at least 25 μs. The resulting containment time n_τ of near 10^{12} s cm^{-3} remains a factor of 2 to 3 below the upper limit given by the classical diffusion. The following loss of the equilibrium position near the coil axis ($\Delta \approx$ 1 to 2 cm) is connected to a strong damping of the axial plasma current, which starts near the end of the containment. It may be assumed that the increase of the effective plasma resistance mainly results from a contact of the force-free regions to the tube wall. Attempts were made to improve the containment by suitable programming of a plasma z-current. The results are presented. Experiments with one quartz limiter inside the torus improved the equilibrium but introduced instabilities at the new surface of the dilute plasma. In order to get more information about the outer region, the dilute plasma was produced without a dense core and separated from the tube walls by a weak adiabatic compression. Under these Tokamak-like conditions the q-value was varied. In the region of $q \approx 1$ there appeared instabilities that seem to have higher m-modes and rather short wavelengths. In a different kind of field programming, the field distribution of the "diffuse pinch" was realized within an accuracy of 5 to 10% (kT $\approx$ 100 eV, $\beta \approx$ 30%). In contrast to the predictions of MHD theory, stability was observed only for about 3 μs. Then the plasma is totally destroyed, presumably by resistive instabilities. (auth)

38459 (CONF-710607-18) TOROIDAL SCREW PINCH WITH NONCIRCULAR PLASMA CROSS SECTION. Wilhelm, R.; Zwicker, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 17 Jun 1971. 7p. (CN-28/B-7). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Application of MHD theory to a screw pinch or Tokamak with circular cross section shows that equilibrium and stability are obtainable only at β values of the order of several percent. Simple equilibrium and stability considerations for a screw pinch with flat plasma cross section, however, showed that, in this case, β values in the region $\beta \approx 1$ should be allowed. Using the low-inductive capacitor bank ISAR IV in a toroidal discharge chamber with a volume of 220 liters in a flat geometry (50 cm mean diameter, 100 cm height), the plasma is produced by a fast-rising magnetic field (rise time 6 μs, e-folding time $\approx$ 1 ms, peak field 10 kG). Results concerning equilibrium and stability of this flat plasma in the temperature regime of 100 to 500 eV are reported. (auth)

38460 (CONF-710607-20) DYNAMIC STABILIZATION OF THE m = 1 MODE ON A SCREW PINCH. Becker, G.; Gruber, O.; Herold, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 17 Jun 1971. 13p. (CN-28/B-9). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Dynamic stabilization of the helical m = 1 instability characteristic for the high-β screw pinch was studied in the linear device Isar III (T_i = 50 to 200 eV; $\beta \approx$ 0.5). The growth rates ω_i and wavelengths of these modes were found to be very similar in the toroidal and linear "Isar" screw pinches for adequate plasma parameters. Mainly, two methods of dynamic stabilization were investigated: (1) superimposing an axially uniform hf B_z field $\tilde{B}_z$ on the quasi-steady B_{z0}; and (2) superimposing a hf axial current $\tilde{I}_z$ on the screw pinch. Preliminary experiments were performed with the magnetic field configuration of a standing wave. The stabilizing effect of the axially uniform $\tilde{B}_z$ is very likely caused by inertial forces in the oscillating plasma column. Working with two stabilizing frequencies ω_s, a stabilizing condition $\epsilon > C\omega_i/\omega_s$ holds ($\epsilon = \tilde{B}_{z0}/B_{z0}$). The experimentally determined C values were about 1.5 to 2.5. It is further demonstrated that the fulfillment of this condition is facilitated when working in resonance with the natural plasma oscillation. The application of the $\tilde{B}_z$ method is limited by wall breakdown. Oscillating currents $\tilde{I}_z = \tilde{I}_{z0} \sin \omega_s t$ with ω_s = 4.8 and 8×10^6 sec^{-1} were added to the quasi-stationary I_{z0} to study the stabilization by dynamic shear. Magnetic probe measurements revealed that, for both ω_s's, the $\tilde{I}_z$ (after initial transients) do not penetrate to the dense plasma column. Nevertheless, a reduction of the m = 1 growth rate occurred for $\tilde{I}_{z0} \approx I_{z0}$ which was higher the more $\tilde{I}_z$ flowed close to the plasma core. The skin depths observed for the $\tilde{I}_z$ were larger than those expected from classical theory, in accordance with a measured high anomalous resistivity. (auth)

38461 (CONF-710607-21) PENETRATION OF THE ION-ACOUSTIC BARRIER WHEN AN ALTERNATING CURRENT FLOWS IN A TOROIDAL MAGNETIZED PLASMA. Demirkhanov, R. A.; Kirov, A. G.; Zharikov, V. N.; Zhdanov, V. A.; Malykh, N. I.

(Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). 17 Jun 1971. 23p. (In Russian). (CN-28/B-10). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Investigation of the phenomena accompanying the flow of an alternating current subject to the skin effect in a magnetized toroidal plasma (when the drift velocity of the electrons u_e can exceed the ion sound velocity c_s) is of interest when considering the possibility of using hf fields in the megahertz range for the dynamic stabilization of plasmas. The phenomena accompanying the flow of an alternating current in a magnetized toroidal plasma pinch in the R-Om device are described. Two cases are investigated: (a) A relatively weak hf current ($I \approx 2$ kA, $f = 0.2$ Mc) in a quasi-continuous régime (pulse duration $\tau_1 \simeq 1$ ms); and (b) A short hf current pulse ($I \approx 10$ kA, $f = 0.5$ Mc) with a constant damping time $\tau_2 \simeq 10$ μs. (auth)

38462 (CONF-710607-22) HIGH-FREQUENCY STABILIZATION OF A CURRENT-CARRYING TOROIDAL PLASMA COLUMN IN A LONGITUDINAL MAGNETIC FIELD. Vasilevskii, M. A.; Roife, I. M.; Seredenko, E. V. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). 17 Jun 1971. 16p. (In Russian). (CN-28/B-12). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The "Tolosokop" device was used to study a stabilized current-carrying toroidal plasma column in a longitudinal magnetic field for a stability margin coefficient $q \leq 1$. The boundaries of the stability regions determined in the experiment for various quasi-constant and high-frequency (stabilizing) current ratios are compared with estimates based on the model of a plasma column with a boundary in the region of the high-frequency-current skin effect. (auth)

38463 (CONF-710607-23) EXPERIMENTAL STUDY OF DRIFT WAVE STABILIZATION. Keen, B. E.; Stott, P. E. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 11p. (CN-28/B-13). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The stability and containment of a magnetically confined low-β plasma may be seriously weakened by drift waves. These are driven unstable by a plasma density gradient in both collisionless and collisional plasmas. Various ac and dc stabilization techniques including magnetic shear, feedback, and dynamic methods were studied. The dc shear stabilization was studied in a 4-meter-long column of thermally ionized alkali-metal plasma. At densities of 10^8 to 10^9 cm^{-3} and with $T_e = T_i = 0.2$ eV, the electron mean free path is longer than the length of the column and the plasma is collisionless. A strongly sheared magnetic field is produced by means of an $l = 3$ helical winding surrounding the plasma. As the shear is increased from zero, the amplitude of the unstable drift waves is reduced until stability is reached for values of the shear parameter $\theta \sim 0.1$. Successful experiments were performed on the feedback stabilization of collisional drift waves in various gaseous arc plasmas ($n \sim 10^{11}$ to 10^{12} cm^{-3}; $T_e \sim 5$ eV). The results were interpreted in terms of nonlinear theory of the Van der Pol type which predicts a variation of the instability amplitude and its frequency as a function of the gain and phase angle in the feedback loop. Comparison between these predictions and experimental results shows good agreement. Dynamic stabilization of collisional drift instabilities was demonstrated in helium and hydrogen afterglow plasmas ($n \sim 10^{10}$ cm^{-3}, $T_e \sim 0.1$ eV), in which an oscillating azimuthal magnetic field, B_θ, at a frequency "ω" is applied to the plasma, perpendicular to the main confining field, B_z. The B_θ field was generated by passing an ac current at frequency "ω" either through a central conductor immersed in the plasma, or through a series of peripheral conductors external to the plasma in a "picket-fence" arrangement. The mechanism for stabilization, in this case, is that the azimuthal field, B_θ, provides a path for electrons to cross the dc field lines, thus "short-circuiting" the instability. The instability was stabilized with moderate values of B_θ/B_z (~1%), the applied frequencies being in the range 0.1 to 10 MHz. In each case, the stabilization technique was successful in reducing the instability amplitude, and the cross-field diffusion was decreased. (auth)

38464 (CONF-710607-24) FEEDBACK AND DYNAMIC STABILIZATION METHODS AND THEIR POWER REQUIREMENTS: A COMPARATIVE EVALUATION. Hendel, H. W.; Chu, T. K. (Princeton Univ., N. J. Plasma Physics Lab.). 17 Jun 1971. 11p. (CN-28/B-14). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Experiments on linear and nonlinear feedback and on dynamic stabilization of drift and transverse Kelvin-Helmholtz instabilities are described and compared with theory. Experimental results on number of modes stabilized, growth-rate ranges affected, and power required are used to evaluate these nonstatic methods for applications in fusion plasmas. Linear feedback ($f_{fb} = f_{inst}$; specific phase required) reduces instability amplitude by two orders of magnitude. It is frequency- and mode-selective and most easily used near marginal instability; stabilization of many oscillatory modes simultaneously is difficult. Remote feedback was demonstrated. Nonlinear feedback (repetition rate $\leq f_{inst}$; specific phase required), uses a constant corrective signal whenever the instability amplitude grows above a present level. It may be applied at repetition rates below the instability frequency. Results are comparable to those of linear feedback. However, harmonics or higher modes are easily destabilized. Dynamic methods ($f_{dyn} \gg f_{inst}$; no phase requirement) are observed to stabilize not only many modes of one instability, but also broad-band turbulence and different instabilities simultaneously, in agreement with the interpretation based on generation of a new dynamic equilibrium stable against a class of instabilities. Power requirements may determine feasibility of nonstatic stabilization in fusion plasmas. For linear feedback, since the suppressing signal is proportional to the instability amplitude, the power necessary for stabilization is relatively small. For dynamic stabilization, or equivalently, for the generation of a stable dynamic equilibrium, the required energy per growth time ($1/\gamma$) is independent of instability amplitude and comparable to a fraction of the plasma internal energy. Feasibility, therefore, is determined by dissipation. The required power for feedback stabilization is $P_{fb} \approx \omega\eta^2(bn_0kT) \sim \eta^2\gamma^3$, while for dynamic stabilization $P_{ds} \approx 10\ \omega(bn_0kT) \sim 10\ \gamma^3$, where ω and η are instability frequency and normalized amplitude, and bn_0kT is a fraction of the internal energy. Calculated power levels are in agreement with experiments. These considerations indicate that, for high-growth-rate instabilities, the power required for dynamic stabilization may be excessive. (auth)

38465 (CONF-710607-35) NEOCLASSICAL EFFECTS ON PLASMA EQUILIBRIA AND ROTATION. Rosenbluth, M. N.; Rutherford, P. H.; Taylor, J. B.; Frieman, E. A.; Kovrizhnikh, L. M. (International Centre for Theoretical Physics, Trieste (Italy). Princeton Univ., N. J.). 17 Jun 1971. 15p. (CN-28/C-12). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

In a toroidally confined plasma there are two possible senses of plasma rotation: i.e., about the major axis of the torus and about the magnetic axis. Stringer and others have discussed instabilities associated with this latter rotation in the short mean free path (classical) régime. Such rotation is strongly damped by ion parallel viscosity towards the lower collision frequency limit. In the lower collision frequency (banana and plateau) régimes, such rotations are shown to be damped by collisionless processes. Rotation about the major toroidal axis can be changed only by collisional diffusion of angular momentum across magnetic surfaces. This problem is formally equivalent to the calculation of higher-order (fourth order in gyro radius) diffusion with the radial electric field ($E_r = v_T B_p$) being chosen such as to eliminate the nonambipolar effects. This fourth-order calculation is feasible since the axisymmetry permits the diffusion to be expressed exactly by a set of moments of the collision operator with powers of the parallel velocity. These moments may then be evaluated by using approximate collision operators or, with the exact Fokker-Planck operator, by variational techniques. In the banana régime, to lowest order in r/R, the longitudinal velocity, $v_T = (T/eB_P)(n'/n + e\phi'/T - 0.17T'/T)$ evolves according to $n(\partial v_T/\partial t) = 0.2(1/r)(\partial/\partial r)\ (r/R)^2\ n(mT/e^2B_p^2)\ \nu_{ii}\ r(\partial v_T/\partial r) + 0.7(1/r)(\partial/\partial r)\ (1/eB_p)(\partial/\partial r)\ (r/R)^{\frac{1}{2}}\ n\nu_{ii}(mT/e^2B_p^2)\ r(\partial T/\partial r)$, where ν_{ii} is the conventional average ion-ion collision frequency, B_P is the poloidal field, and all quantities refer to ions. The first term represents a perpendicular viscosity, showing no particular enhancement due to banana effects. Thus, viscous relaxation is slow compared to ion thermal diffusion, which is governed by the usual ion neoclassical energy-balance equation. The second term, however, shows a surprising effect of ion temperature gradients on rotation, inasmuch as very large [$e\phi \sim 3(R/r)^{\frac{1}{2}}T$] ambipolar potentials are induced. In the plateau régime the first term is not affected, while the second varies as $\nu^{-\frac{1}{2}}$, so that the usual equilibria prevail towards the classical régime. The effect of small deviations from axisymmetry is discussed. (auth)

38466 (CONF-710607-60) THEORY OF STRONG TRAPPED-PARTICLE TURBULENCE. Drummond, W. E. (Austin Research Associates, Inc., Tex. Texas Univ., Austin); Thompson, J. R.; Sloan, M. L. (Austin Research Associates, Inc., Tex.); Wong, H. V. (Texas Univ., Austin). 17 Jun 1971. 33p. (CN-28/E-12). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A model is presented for the final state of the streaming instability driven by a dc electric field in a cold collisionless plasma. This state consists of large-amplitude traveling electric field fluctuations, which limit electron runaway by trapping most electrons. Poisson's equation dictates the existence of a few untrapped electrons, which may be arbitrarily presumed to be in a strip just outside the separatrix, without significantly influencing the velocity or energy of the turbulent wave. The ions are considered in the adiabatic approximation. The time dependence of this state is examined through an ansatz of multiple time scaling. One finds a transition between adjacent metastable states, which proceeds slowly compared to the time scale of wave motion but rapidly compared to the time scale of wave decay. The trapping of the bulk electrons appears to be dynamically maintained, with the ions remaining marginally untrapped. The thermodynamic properties of these quasi-stationary states are computed in detail, after first obtaining the distribution of the trapped electrons as a function of the electric potential according to the Bernstein–Greene–Kruskal formalism. Although a sinusoidal potential is used as a first example, the quasi-linear effects of short-wavelength instabilities on the BGK background state allow the calculation of the actual wave shape. The wave-frame distributions of electrons and ions, together with the condition for momentum conservation, are sufficient to determine the ratio of the ion sound speed to the wave phase velocity and the ratio of the potential energy to the kinetic energy of electrons or ions. Significantly, the ion sound speed is found to exceed the phase velocity. The transition between metastable states further entails continued heating of the trapped particles and growth of the wave, while at the same time the phase velocity of the wave slowly declines. The coherent sloshing energy of the ions approaches 40% of the electron thermal energy. If this asymptotic state can be reached experimentally, the consequences will be: (1) much higher temperatures than previously anticipated can be reached; and (2) rapid penetration of electromagnetic fields at speeds above even that of the usual turbulent diffusive velocity. (auth)

38467 (CONF-710607–72) MAINTAINING EQUILIBRIUM IN THE UNCASED TO-1 TOKAMAK DEVICE BY MEANS OF A FEEDBACK SYSTEM. Artemenkov, L. I.; Golovin, I. N.; Kozlov, P. I.; Milikhov, P. I.; Shvindt, N. N. (Institut Atomnoi Energii, Moscow (USSR)); Butenko, V. K.; Ladikov-Roev, Yu. P.; Kukhtenko, A. N.; Samoilenko, Yu. I.; Gubarev, V. F. (Akademiya Nauk Ukrainskoi SSR). 17 Jun 1971. 8p. (In Russian). (CN–28/C-3). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A system was designed for automatically controlling the equilibrium position of the plasma column in a Tokamak device without copper casing, using an arrangement of spaced windings and regulators. The TO-1 Tokamak device was built for this study. Its main parameters are: major radius 60 cm; minor radius (diaphragm) 15 cm; maximum longitudinal magnetic field 20 kG; maximum plasma current 100 kA; maximum magnetic flux of the transformer for Joule heating 0.44 Wb. The single-wall vacuum chamber is made of 1-mm stainless steel with a ceramic insert. The chamber has four diagnostic tubes spaced uniformly around the torus. Between the solenoid of the longitudinal field and the vacuum chamber there is a system of spaced windings consisting of eight sections; four sections are above the equatorial plane of the torus and four below. The windings can be connected with one of three regulators, depending on the distribution of the stray magnetic fields. The type of regulator adopted is for a maximum plasma current of 30 kA. When there is no plasma current, the system uses virtually no power. With this regulator system it is possible to reduce the displacement of the plasma column by comparison with the displacement that occurs when a superconducting casing is used. (auth)

38468 (CONF-710607–75) ROTATING TOROIDAL EQUILIBRIA AND SHOCKS. Winsor, N. K.; Bowers, E. C.; Dawson, J. M. (Princeton Univ., N. J. Plasma Physics Lab.). 17 Jun 1971. 9p. (CN–28/F-4). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A low-β axisymmetric fluid model shows enhanced material flux and shock structure for stellarator or low-temperature Tokamak parameters. Numerical calculations agree with analytic results and predict the equilibrium potential distribution, given the radial density distribution. They also provide insight into previously unexplained deviations of equipotential surfaces from magnetic surfaces in the Etude stellarator. The fluid model includes ion inertia, resistivity, and viscosity, plus the Hall terms in Ohm's law and a tensor pressure in the momentum equation. The magnetic field model includes curvature, rotational transform, and shear. Acoustic, drift, and convective modes are present. Analytic equilibrium calculations show that the material flux is nearly classical when the poloidal rotation speed $V_E = E/B$ is small compared to the electron drift velocity, and larger when $V_E \approx -V_d^e$. Stability calculations show that an equilibrium with $V_E = 0$ is unstable, and furthermore that only one direction of rotation is stable. The sign of the potential is determined by a balance between resistivity and viscosity. If resistive effects dominate, the electron flow perpendicular to B becomes small, giving a positive potential on axis. If the ion viscosity dominates, the ion flow tends to zero, giving a negative potential. The potential on the magnetic axis is negative in the Princeton ST device. The model predicts this result, given the experimentally measured electron and ion temperatures in the machine. For the lower temperatures obtained in many stellarator experiments, resistive effects dominate and one finds a positive potential on axis—again in agreement with experiment. The model also predicts the formation of an acoustic shock, leading to increased dissipation and more-rapid material loss. This shock produces an asymmetrical density distribution, similar to measurements in the Etude stellarator. Parameters for a typical stellarator simulation were: an aspect ratio of 20, $T_e = T_i = 15$ eV, $\iota = 90°$, $B = 10^4$ gauss, density of 10^{13} cm^{-3} of hydrogen, and Spitzer resistivity. After the plasma reached its rotational equilibrium, the containment time was 3.5 msec. If one allows for an anomalous resistivity factor of 5, this time would be <1 Msec in agreement with experimental observations. (auth)

38469 (CONF-710607–76) INVESTIGATION OF MACROSCOPIC INSTABILITIES OF A PLASMA COLUMN IN TOKAMAK DEVICES. Mirnov, S. V.; Semenov, I. B. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 8p. (In Russian). (CN–28/F-5). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

An investigation was carried out in Tokamak-3 and Tokamak-4 of the instabilities of a plasma column that occurred when $q = (H_z/H_\varphi)(a/R)$ (where H_z is the stabilizing magnetic field, H_φ the longitudinal current field, a the minor radius of the column, and R the major radius) assumes the integral values: 3, 2 and 1. It was demonstrated that, for these conditions at the column boundary, a resonance-type instability develops, with $m/n = q$ (where m and n are the transverse and longitudinal azimuthal numbers). The reduction of q right down to unity was achieved by increasing the longitudinal current during discharge. If q near the boundary does not assume integral values, the plasma column becomes more stable than when resonances are present. In addition to the instability with integral q values close to the boundary, the plasma column instabilities that occur when the plasma density is increased to the critical value and also the instabilities arising when the plasma loop is widened under the influence of transverse magnetic fields were studied. In these cases intense resonance perturbations in the plasma were encountered when m = 3 (or 4), which indicates either a reduction in the radius of the plasma column or a loss of stabilization of the resonance perturbations localized within the column. The perturbations were investigated by correlative analysis of the spatial fluctuations of the discharge current magnetic field. Optical and x-ray methods were also used for this purpose. (auth)

38470 (CONF-710607–78) STABILITY EXPERIMENTS ON THE ST TOKAMAK. Hosea, J. C.; Bobeldijk, C.; Grove, D. J. (Princeton Univ., N. J. Plasma Physics Lab.). 17 Jun 1971. Contract AT(30-1)-1238. 19p. (CN–28/F-7). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Two phases of instability are observed on the ST Tokamak: (1) slow-growing, small-amplitude oscillatory modes, followed by (2) fast-growing, sometimes destructive, instabilities that can limit the attainable q value. The results point to the importance of the plasma profile and the relative unimportance of the copper shell for stability. The mode structure $[\exp(im\theta - in\phi)]$ and amplitude of the slow-growing oscillations were determined with multiple probes and also with microwave interferometry. When the plasma current is raised to a fixed plateau value, with constant toroidal and vertical magnetic fields, the dominant mode number m in the plateau regime is found to decrease in time while n remains unity. A faster decrease in m is produced by pulsing in gas to cool the edge of the discharge or by operating the machine under less-clean conditions. The decrease in time of m for fixed q_a suggests that the peaking of the plasma temperature profile is accompanied by a shrinking of the plasma current channel, which in turn reduces q at the mean radius of the channel. The modes rotate in the electron diamagnetic drift direction and have frequencies close to the electron diamagnetic frequency. The fast-growing instability, following the slow-growing oscillation, is characterized by negative

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voltage and positive current spikes, followed in the extreme cases (voltage spikes of several hundred volts) by strong current perturbations. Simultaneous inward major radius shifts are apparently insufficient to account for the negative voltage spikes. Changes in internal inductance and/or β_θ are being studied. Peaking of the plasma temperature (current density) profile promotes the fast-growing instability. On the other hand, for the present degree of proximity, the copper shell (18 cm radius) does not appear to be very important. By means of parallel bar limiters, plasma columns were produced that cover the range a = 4 to 14 cm, and practically the same degree of stability was found for a given q_a value (down to 2.5). This finding appears to open the way for considerable simplification in the construction of tokamak devices. (auth)

38471 (CONF-710607-80) COLLECTIVE MODES IN HIGH CURRENT CARRYING CONFINED PLASMAS. Callen, J.; Coppi, B.; Dagazian, R.; Gajewski, R.; Sigmar, D. (Massachusetts Inst. of Tech., Cambridge). 17 Jun 1971. Contract AT(30-1)-3980. 28p. (CN-28/F-9). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Confinement configurations allowing for high plasma current densities are potentially suitable to reach new regimes which, in terms of certain basic parameters (e.g., ratio of collision frequency to particle bounce frequency), are typical of thermonuclear plasmas. The influence of the plasma cross section profile on the maximum current density that can be achieved in two-dimensional toroidal configurations is analyzed. The MHD stability and equilibrium are examined for a plasma column with a conducting shell close to it and with an elliptic and triangular deformation imposed over a circular cross section profile. Since the configurations of interest also have a low aspect ratio and a large fraction of trapped particles, the stability of collisionless kinetic modes involving trapped particles is studied, taking into account the effect of the electron current. Effects related to the simultaneous presence of different kinetic modes are considered, and the possible stabilizing factors of interchange trapped-particle modes are pointed out. The relevance of collisional modes, due to finite thermal conductivity and electrical resistivity and driven by a radial gradient of the current density, is pointed out as a possible explanation of the lack of skin effect or of plasma confinement in significant regimes. The electrical resistivity and electron thermal conductivity are assessed, taking into account the effects of trapped particles, finite aspect ratio, and excited fluctuations. (auth)

38472 (CONF-710607-82) EQUILIBRIUM AND MHD STABILITY IN TOKAMAK AND HYBRID SYSTEMS. Jukes, J. D.; Haas, F. A. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 17p. (CN-28/F-11). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Axisymmetric, toroidal, plasma equilibria are examined according to MHD theory. The plasma is assumed to lie in a magnetic field with a strong toroidal component B_0, within a toroidal flux surface of small reciprocal aspect ratio κ. The flux surfaces are assumed to be nested around a single magnetic axis, and shaping of the minor cross section with up to three harmonics is considered. The required shape may be imposed either by a rigid conducting shell or by an external vacuum magnetic field. The equilibrium plasma pressure p has a maximum value on the axis such that $2p_0/B_0^2 \equiv \beta_0 \leq \beta_{max} = A\pi/q_0^2$, where q_0 is the reciprocal rotational transform close to the axis and $A(\lesssim 1)$ is a numerical factor determined by the forbidding of a second magtic axis. Its precise value depends on current distribution and geometry and is given for some simple cases. The stability limit on β_0 is generally much lower, however, especially if shear stabilization is weak. An expression for the energy perturbation, which gives a stability criterion valid for mode numbers, is derived in a form suitable for further numerical study. Specific results are given only for localized interchange modes in a form containing shear, average magnetic well, and ballooning effects, evaluated for simple, shaped profiles. A feature of shaped flux surfaces is the added shear and well depth they provide in combination with the transform due to the plasma current, whose precise distribution is no longer so critical for stability. (auth)

38473 (CONF-710607-83) THE EQUILIBRIUM, STABILITY, AND DIFFUSION OF A TOROIDAL PLASMA OF NON-CIRCULAR CROSS SECTION. Laval, G.; Luc, H.; Maschke, E. K.; Mercier, C.; Pellat, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 17 Jun 1971. 12p. (In French). (CN-28/F-12). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The equilibrium and magnetohydrodynamic stability of a Tokamak configuration of noncircular cross section are studied to determine whether the theoretical limiting values of β and of the current density can be raised by suitably choosing the cross section form. Cases of equilibrium are considered in which the form given to the plasma cross section is elliptical or triangular. A limit for the existence of equilibrium appears for a β^* (= β poloidal) value for which the poloidal magnetic field is zero at the edge of the plasma. In the case of an elliptical cross section the limiting value for equilibrium β_{eq}^* is proportional to $(b^2 - a^2)/(b^2 + a^2)$, where b and a are, respectively, the vertical and horizontal semi-axes of the ellipse. In the case considered here, where triangular deformation of the cross section is slight, its influence on the limiting value of β^* is negligible. The MHD stability of such equilibrium states is studied in terms of the energy principle for localized perturbations or for ballooning and kink. In the case of an elliptical cross section, for $\beta^* \ll \beta_{eq}^*$, the localized criterion indicates that the horizontal ellipse gives the greatest current. This current could greatly exceed the Kruskal-Shafranov limit. However, the criterion for the kink modes imposes a more restrictive limit. For values of β^* approaching the equilibrium limit, the localized criterion indicates that any degree of ellipticity is unfavorable. If even slight triangular deformation is superimposed on the elliptical section, the limits set by the localized criterion are completely changed in the neighborhood of the magnetic axis. The plasma then remains stable for stronger current densities and for higher values of β than in the case of a circular cross section. The criterion for the kink modes, however, is not affected by the presence of this slight triangular deformation. The classical diffusion of particles depends on the shape of the cross section, but that does not limit the choice of this shape. On the basis of all the results obtained, the possibility of improving the Tokamak configuration by suitable choice of cross section is discussed. (auth)

38474 (CONF-710607-85) M.H.D.-STABILITY OF AXISYMMETRIC PLASMAS. Kueppers, G.; Pfirsch, D.; Tasso, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 17 Jun 1971. 14p. (CN-28/F-14). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A class of axisymmetric magnetohydrostatic tokamak-like equilibria is considered. In these equilibria, the plasma is surrounded by a vacuum and a perfectly conducting wall. Test functions, which are modified eigenfunctions for similar cylindrical equilibria, are used. The existence of nonlocalized higher "m" instabilities below the Kruskal limit can be proved exactly. An underestimate of their growth rate can also be given. In an actual device, a resistive limiter could decrease the growth rate of these instabilities, but they can still enhance the plasma losses. A rough estimate of these losses leads to much higher values than given by the "banana" diffusion formula. In a fusion device, no limiter should touch the plasma, and the instabilities found will probably be very dangerous to the confinement. In addition, Mercier's criterion is computed for an exact class of MHD equilibria containing possibly elliptical cross sections. The main result is that the toroidal current and the plasma beta can be increased by at least one order of magnitude if (a) the eccentricity of the magnetic surfaces, (b) the poloidal current, and (c) the aspect ratio are adequately chosen. (auth)

38475 (CONF-710607-86) DISSIPATIVE DRIFT MODES IN TOKAMAK-TYPE CONFIGURATIONS. Adam, J. C.; Laval, G.; Pellat, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 17 Jun 1971. 13p. (In French). (CN-28/F-15). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

In a toroidal configuration with a large aspect ratio, the curvature of the main field makes it possible to localize drift modes in the outer part of the plasma section. Hence, a means is available for producing perturbations of considerable radial extension, whose phase velocity parallel to the magnetic field remains higher than the ion thermal velocity in spite of the shearing of the field lines. The limits of stability and the growth rate of these modes are determined as a function of collision frequency and temperature gradient on the basis of the Fokker-Planck equation. The existence of trapped electrons is necessary, and this implies an effective collision frequency less than the electron oscillation frequency along the field lines. If the collision frequency is very low, the temperature gradient has a stabilizing effect. For effective collision frequencies much higher than the drift wave frequency, the temperature gradient determines the growth rate, which decreases as the collision frequency increases. There is an intermediate régime for which the growth rate no longer depends explicitly on temperature gradient or collision frequency but is proportional to the effects of the finite Larmor radius of the ions. These modes differ from the nonlocalized collisional

mode studied by Kadomtsev and Pogutze: the radial localization is independent of shearing, and the instability region is more extensive. The corresponding transport coefficients are estimated, and continuity with the customary drift waves when the effective collision frequency is higher than the electron oscillation frequency along the field lines is discussed. (auth)

38476 (CONF-710607–87) NONLINEAR KINK AND TEARING MODE EFFECTS IN TOKAMAKS. Rutherford, P. H.; Furth, H. P.; Rosenbluth, M. N. (Princeton Univ., N. J. Plasma Physics Lab.). 17 Jun 1971. Contract AT(30-1)-1238. 20p. (CN–28/F-16). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

In the cylindrical approximation, a tokamak plasma of radius a with uniformly distributed longitudinal current and an outer vacuum region bounded by a conducting wall of radius b is hydromagnetically unstable to kinks if $0 < m - nq_a < 1 - (a/b)^{2m}$. If there is an outer region $a < r < c < b$ of conducting plasma, free of longitudinal current in the equilibrium, then linear stability is increased. To obtain limiting amplitudes for kink modes, two simple models close to marginal stability were considered, and neighboring slightly kinked (bifurcated) helical equilibria were calculated. The stability of these equilibria against perturbations with similar helical symmetry is discussed: cases of stable and unstable neighboring equilibria are found. Typically, the outer region of conducting plasma is strongly stabilizing nonlinearly. The second-order change in total plasma current at constant external poloidal flux is calculated, both for the helical equilibrium and during the mode growth: the current change is normally negative (corresponding to a positive voltage spike) but in unusual cases it can be positive. The current change is also calculated for the tearing mode where the outer region is resistive plasma; here it is always negative. The second-order paramagnetism is calculated using the radial virial theorem: although both modes are normally paramagnetic, a diamagnetic component for the tearing mode arises from the inertia of the tearing layer during mode growth. The paramagnetism gives an estimate of the second-order (inward) major radius shift, which gives rise to a slightly increased current. In order to provide a detailed explanation of the experimental results, it appears necessary to examine additional physical phenomena: in particular the weak oscillations seen before onset of large disturbances and nonlinear effects on the structure of the magnetic surfaces. (auth)

38477 (CONF-710607–91) HIGH-BETA RELATIVISTIC ELECTRON PLASMAS IN AXISYMMETRIC AND NON-AXISYMMETRIC MIRRORS. Dandl, R. A.; Eason, H. O.; Edmonds, P. H.; England, A. C.; Guest, G. E.; Hedrick, C. L.; Hogan, J. T.; Sprott, J. C. (Oak Ridge National Lab., Tenn.). 17 Jun 1971. 15p. (CN–28/G-4). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Plasmas with $kT_e \sim 1$ MeV, $n \sim 10^{12}$ cm^{-3}, and stored energies as high as 360 joules in a volume of 2 liters were produced and confined in a 2:1 mirror trap (ELMO) using simultaneous resonant (35-GHz) and off-resonant (55-GHz) cw microwaves. The stable, steady-state, relativistic electron plasma is confined in an axisymmetric annular region near the midplane of the mirror trap. The self-consistent magnetic field has a minimum in the annular region, so that the main body of the plasma is in a magnetic well. The outer surface of the plasma is in a region of unfavorable curvature and is stabilized by line tying to conducting end walls. The amount of cold plasma required for particle equilibrium exceeds by two orders of magnitude that required for stability. A new machine was constructed to study the limitations on equilibrium and stability of a high-beta plasma ring resulting from deformation of the initially axisymmetric mirror trap into one sector of a "bumpy torus" geometry. In these experiments the mirror coils are mechanically rotated through equal angles in opposite directions about parallel axes which are perpendicular to the original axis of symmetry of the mirror. The effects of the high-beta plasma equilibrium on the non-axisymmetric confinement geometry are being ascertained. This experiment is the first step in a program whose eventual goal is a toroidally confined plasma incorporating a set of mirror-confined high-beta plasma rings. (auth)

38478 (CONF-710607–95) INVESTIGATION OF ION–CYCLOTRON INSTABILITY IN A PLASMA FORMED BY FAST IONS IN A MAGNETIC MIRROR TRAP. Bortnikov, A. V.; Brevnov, N. N.; Zhukovskii, V. G.; Pergament, V. I.; Romanovskii, M. K. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 32p. (In Russian). (CN–28/G-8). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

At the moment when the fast ions are filling the trap they either rotate coaxially with the axis, forming a thin cylindrical layer, or fill the cross section of the trap. Trapping is accomplished with the help of the pulsed magnetic field constituting one of the mirrors. The behavior of the plasma is very different in the two cases. In the first case, a low noise level is observed before trapping of the plasma. After trapping in the magnetic mirror trap, however, ion-cyclotron oscillations of two types develop in the plasma. First of all, there occurs a short (≈100 μs) burst of oscillations at a frequency other than the ion-cyclotron frequency; then oscillations begin at the ion-cyclotron frequency and continue throughout the plasma lifetime. The measured spectral characteristics of the oscillations, the growth rates, the wavelengths, and the density dependence of the electric fields point to the successive occurrence of two different instabilities. During the first instability there is an escape of fast electrons through the magnetic mirrors, while some of the trapped ions escape across the magnetic field. The second instability does not cause any pronounced additional particle losses from the trap. The development of both the first and the second instability is considerably affected by the form of the longitudinal and transverse energy distribution function of the fast ions: depending on the form of the fast ion distribution function, either the first instability occurs alone, or the first and second occur together, or no instability occurs at all. In the second case, strong ion-cyclotron oscillations are observed before trapping of the plasma (in the penetrating-beam regime) if the plasma density exceeds some threshold value. Only the basic ion-cyclotron frequency is observed in the hf oscillation spectrum when the plasma density is near the threshold value. As the plasma density increases, harmonics of the ion-cyclotron frequency occur. When the plasma density is several times greater than the threshold value (but nevertheless $\omega_{pi} \ll \omega_{Bi}$), the harmonics spread and the frequency spectrum becomes continuous. It follows from a wave analysis that long waves (of the order of the size of the plasma) correspond to a discrete spectrum and shorter waves to a continuous spectrum. There is also a marked broadening of the fast-particle energy spectrum in the reflection region relative to the energy spectrum of the injected beam. After trapping of a plasma in the field of a simple magnetic mirror configuration, the high-frequency oscillations quickly vanish; however, the plasma decays rapidly due to the development of flute instability. After trapping of a plasma in a field with minimum B, the oscillation intensity depends on the plasma density. When the plasma density is near the threshold, there is a short, abrupt increase in the intensity of the ion-cyclotron oscillations, after which the oscillations vanish, although the density of the trapped plasma takes a long time to decline. If the plasma density is higher, the oscillations are quickly damped. At the same time there is a considerable change in the energy spectrum of the neutral particles: the number of particles possessing the injection energy decreases. An appreciable number of these particles escape from the trap. (auth)

38479 (CONF-710607–115) HIGH β (l = 1)-STELLARATOR EXPERIMENTS. Fuenfer, E.; Kaufmann, M.; Lotz, W.; Neuhauser, J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 17 Jun 1971. 13p. (CN–28/J-3). Dep. NTIS (U. S. Sales Only).

From fourth conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The experiments were done in straight as well as in toroidal geometry. In all cases the plasma was heated by shock waves (theta-pinch). In straight helical geometry, a 5.4-m-long coil was used in essentially four different versions. In all cases the typical plasma helix was formed after the fast compression. Oscillations correlated with the helix formation could be explained by MHD theory. At high temperatures ($T_e + T_i \approx 0.5 \ldots 2.1$ keV) one observed ($m = 1$, $k \approx 0$) instabilities. A reduction in β of 20% led to much lower growth rates, in agreement with the theory. From internal magnetic probe measurements, magnetic field profiles and beta values were derived. The field profiles indicated that longitudinal currents also flow in the thin plasma ("halo") outside the dense plasma column. Such currents may influence the plasma stability. In a small toroidal pre-experiment (bank energy 10 kJ, major radius 26 cm) with low aspect ratio $A > 1$, effects not seen in a straight geometry were studied. The helical field was generated by a shaped coil. As in the linear experiment a helix was formed, and oscillations of the helix radius were observed. A net toroidal current, induced by the (l = 1) field, could be explained by a simple model. The shape of the magnetic field was varied and the toroidal plasma current was changed in both directions. The toroidal drift motion of the plasma helix was a function of the various parameters. With a toroidal current well above the Kruskal limit, a highly unstable, screw-pinch-like equilibrium was found. (auth)

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38480 (CONF-710607-116) THETA-PINCH EXPERIMENTS WITH HELICAL EQUILIBRIUM FIELDS IN A 5-METER TOROIDAL SECTOR AND IN A 3-METER LINEAR DEVICE. Burnett, S. C.; Ellis, W. R.; Hammer, C. F.; Harder, C. R.; Harris, H. W.; Jahoda, F. C.; Quinn, W. E.; Rawcliffe, A. S.; Ribe, F. L.; Sawyer, G. A.; Siemon, R. E.; Thomas, K. S.; Zimmermann, E. L. (Los Alamos Scientific Lab., N. Mex.). 17 Jun 1971. Contract W-7405-eng-36. 19p. (CN-28/J-4; LA-DC-12208). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Experiments are reported on a θ-pinch sector comprising one-third of the Scyllac torus of major radius R = 237.5 cm and plasma radius a ≈ 1 cm (aspect ratio R/a ≈ 240). Equilibrium is obtained by balancing the toroidal force by means of an l = 1 helical field, which produces a helical shift $R_0 = a\delta_1$ of the plasma column approximately equal to its radius ($\delta_1 \approx 1$) and a small admixture of l = 0 field ($\delta_0 = 0.1$). Both fields have a wavelength of 33 cm. End effects are not expected to dominate before the lapse of one Alfvén (or ion-thermal) transit time τ from the plasma ends. Hence there is sufficient time to observe the attainment of equilibrium and some of its stability properties. Related experiments on a 3-meter linear θ-pinch with superimposed l = 1 fields show that only the m = 1, k ≈ 0 magnetohydrodynamic (MHD) mode occurs. No higher-m modes are seen during the time τ, even though the MHD theory of Grad and Weitzner and Rosenbluth et al., predicts much larger growth rates γ_m for these modes. In the linear experiments, the m = 1 growth rate γ_1 is measured and compared with the theoretical predictions. The magnitude of γ_1 largely determines the difficulty of feedback stabilizing the m = 1 mode. On the linear device, experiments were conducted to determine the feedback coupling force $F_{1,0}$ on the l = 1 plasma column produced by separately driven l = 0 coils, as described by Ribe and Rosenbluth. This force is also used to obtain the toroidal equilibrium of the toroidal sector. The experiments reported here are preliminary to experiments in the complete Scyllac torus of 15-meter circumference. (auth)

38481 (CONF-710607-117) SURVEY OF SCYLLAC THEORY. Freidberg, J. P. (Los Alamos Scientific Lab., N. Mex.). 17 Jun 1971. 13p. (CN-28/J-5). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A survey is given of both old and new theoretical results pertaining to the Scyllac experiment. (auth)

38482 (CONF-710607-118) TOROIDAL HIGH β EQUILIBRIA. Weitzner, Harold (New York Univ., N. Y. Courant Inst. of Mathematical Sciences). 17 Jun 1971. 6p. (CN-28/J-6). Dep. NTIS.

From fourth conference on plasma physics and controlled nuclear fusion research, Madison, Wis. (17 Jun 1971).

The equilibrium and stability of large-aspect-ratio, long-helical-wavelength, high-beta toroidal systems are studied in an ordering that permits moderate deformations of the plasma column, includes toroidal effects in the stability analysis, and yields hopeful stability criteria. (auth)

38483 (CONF-710607-132) THERMAL INSTABILITY AND CONTROL OF FUSION REACTOR. Ohta, M.; Yamato, H.; Mori, S. (Japan Atomic Energy Research Inst., Tokai). 17 Jun 1971. 14p. (CN-28/K-8). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Steady-state fusion reactors will be achieved with plasmas of charged-particle heating or injection heating. The temperature and density of these plasmas can be unstable for deviations from the steady state. The stability criteria are obtained from linearized equations for deuterium-tritium plasma, taking into account the difference between energy and particle confinement times. The possibility of control of these instabilities is also discussed. There seems to be a critical operating temperature, above which the reactor is stable. This temperature is determined from the functional dependence of the energy and particle confinement times on the temperature (T) and density (n). (1) When the energy confinement time is constant, the critical temperature corresponds to the minimum of F. (2) When the confinement time is proportional to 1/T, as in the case of Bohm diffusion, the critical temperature is lower than the previous case. (3) When the confinement time is proportional to $T^{\frac{1}{2}} n^{-1}$, as in classical diffusion, the critical temperature is higher. The temperatures for these three cases are 28 keV, 14 keV, and 42 keV, respectively, in a charged-particle-heated reactor. A wider range of stable operating temperature can be expected in an injection-heated reactor than in a charged-particle-heated reactor. As the operating temperature of steady-state fusion reactors will probably be in the unstable region, some kinds of stabilizations are indispensable in order to suppress this instability. Feedback stabilizations by means of injection rate of fuel, injection energy, and radiation loss are investigated. The delay time in the process is taken into account. The stabilization is shown to be applicable when the feedback is carried out, observing the temperature deviations from a steady state. The nonlinear evolutions of the temperature and density are analyzed numerically. (auth)

38484 (COO-1695-33) PLASMA INSTABILITIES AND WAVES EXCITED BY AN ANISOTROPIC ENERGY DISTRIBUTION PRODUCED BY ELECTRON CYCLOTRON RESONANCE. Quarterly Progress Report No. 16. Shohet, J. L. (Wisconsin Univ., Madison. Dept. of Electrical Engineering). 15 Mar 1971. Contract AT(11-1)-1695. 62p. Dep. NTIS.

Bremsstrahlung measurements were made to determine the polarization distribution of the free-free bremsstrahlung exciting radially along the midplane. The scattering method was used with beryllium as the scattering material. Use of this material, together with improved pulse counting techniques has resulted in a 5-fold increase in the scattered x-ray flux, necessitating counting times of only 200 to 400 minutes. Both wall and free-free bremsstrahlung polarization measurements were made using this method. The theoretical work in this area is concentrating on a direct evaluation of the scattering matrix elements to obtain a definitive measure of the anisotropy of the free-free bremsstrahlung. Three approaches for plasma simulation were studied: the first is consideration of simulation of electron cyclotron resonance in a 2-dimensional region considering interparticle Coulomb fields; the second approach considers heating of a collection of particles without interparticle reactions; and finally, rf confinement of a much-larger number of particles than previously is now possible after modification of an already existing program. In the area of plasma diagnostics, a method of determining the amounts of cold and hot plasma present in the device is being developed. The method is based on a different response to microwaves in a cavity when the plasma is considered warm than when it is cold. Further diagnostic work in the optical spectrum will commence shortly when a monochromator is installed on the system. Finally, further calibration of the scintillator probe used to measure the distribution of electrons in the plasma was made. (auth)

38485 (EUR-CEA-FC-574) ELECTROMAGNETIC MODES OF PARTICLES TRAPPED IN MULTIPOLES. Bussac, Marie-Noelle (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1970. 42p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences.

The stability criteria of a collisionless plasma, confined by a magnetic field whose lines of force are not sheared, are calculated using magnetohydrodynamic and microscopic models. The influence of a finite pressure on the trapped-particle instability is studied. (France)

38486 (ORO-3405-35) INVESTIGATION OF UNIVERSAL PLASMA INSTABILITIES. Annual Progress Report No. 6. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). 1 Jun 1971. Contract AT(40-1)-3405. 23p. Dep. NTIS.

During the past year, work was focused on two problems: (1) the parametric excitation of ion-acoustic waves, primarily experimental work; and (2) analysis of plasma stabilization by so-called open-loop methods, which are to be contrasted with closed-loop or feedback methods. Associated work on the project is described. (M.O.W.)

38487 ELECTROMAGNETIC CYCLOTRON INSTABILITY. Lee, Kai Fong (Catholic Univ. of America, Washington, D. C.). Appl. Phys. Lett.; 18: No. 10, 463-6(15 May 1971).

It is shown that, in plasmas described by model velocity distributions of the "ring" or the loss-cone type, linearly polarized electromagnetic waves propagating across the magnetic field can be unstable around harmonics of the cyclotron frequencies. For suitable combinations of plasma and magnetic field parameters, the maximum growth rates of these electromagnetic cyclotron instabilities are proportional to the plasma frequency and the average of the square of the parallel velocities. (auth)

38488 PARAMETRIC INSTABILITY OF A TOROIDAL HIGH FREQUENCY DISCHARGE IN A MAGNETIC FIELD. Roife, I. M.; Vasilevskii, M. A.; Seredenko, E. V. Zh. Eksp. Teor. Fiz.; 60: No. 5, 1621-6(May 1971). (In Russian).

The magnetohydrodynamic instability observed is of the nature of parametric instability of a high-frequency current in a longitudinal magnetic field. The experimental results are compared with calculations for an ideal magnetohydrodynamic model. (auth)

38489 VELOCITY ANISOTROPY INSTABILITY OF PLASMAS IN HIGH-FREQUENCY ELECTRIC FIELD. Kishimoto, Shunichi; Akimune, Hideo; Suita, Tokuo (Osaka Univ., Suita, Japan). Technol. Rep. Osaka Univ.; 20: No. 942, 461-71(Oct 1970).

Velocity anisotropy instability is considered theoretically in an external rf electric field with frequency near the ion cyclotron frequency. In the external field whose frequency is off-resonant from the ion cyclotron frequency, the unstable mode associated with the ion cyclotron frequency and its harmonics can be stabilized. Though the new unstable rf mode whose frequency $\omega \simeq l\omega_{ci} - \omega_0$ may appear, it can be damped to a certain degree as the result of a parametric effect by the induced electron drift, where ω_{ci} and ω_0 are the ion cyclotron frequency and the external field frequency, respectively, and l is the integer. The stronger off-resonant external field by which the electrons are heated appreciably in the direction of the magnetic line of forces can quench the unstable mode, $\omega \simeq l\omega_{ci} - \omega_0$ by Landau damping; the stronger resonant field may excite the unstable mode, $\omega \simeq l\omega_{ci}$. (auth)

Thermonuclear Processes

Refer also to abstracts 38130 and 38483.

38490 (A/CONF.49/P-836) PROGRESS IN CONTROLLED THERMONUCLEAR RESEARCH. Gould, R. W. (Atomic Energy Commission, Washington, D. C.). Sep 1971. 17p. (CONF-710901-28). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A survey was made of controlled thermonuclear research being carried out in the United States. The programs, their problems, and possibilities for future studies are briefly described for the following research areas: (1) magnetic mirror systems, (2) low-beta closed confinement systems, (3) Astron, (4) high-beta pulsed pinch systems, and (5) engineering and environmental aspects of fusion reactors. (M.O.W.)

38491 (CONF-710607-10) TRAPPING EXPERIMENTS IN THE ASTRON. Christofilos, N. C.; Condit, W. C. Jr.; Fessenden, T. J.; Hester, R. E.; Humphries, S.; Porter, G. D.; Stallard, B. W.; Weiss, P. B. (California Univ., Livermore. Lawrence Radiation Lab.). 10 Jun 1971. 23p. (CN-28/A-9; UCRL-72894). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The results of trapping experiments in Astron are presented. The location of the trapping region was moved 9.5 m from the injection point to prepare for experiments in which pulses are overlapped to build up an E-layer with field reversal. This was made possible by increasing the energy of the injected electrons to 6 MeV. By trapping this far from the inflector, it is possible to use a vacuum field which has a 10% deep well with small radial gradients. Thus the E layers formed are unlikely to be ejected by a second pulse. However, because of the small radial gradients, the threshold for the precessional instability is small, and the E layers that are formed are stable. Single-pulse trapping experiments with these deep, symmetric traps have produced E layers with 5% field reversal (diamagnetic strength 5% of the vacuum field). The injected currents were in excess of 600 A. Electronic equipment, which will shortly provide a burst of 100 electron pulses at a rate of 960 pps, is now available for a burst of three pulses. The first electron pulse is always lost to generate a thin plasma, while the second and third pulses have been stacked. The total circulating current in each of the stacked pulses is 1500 A, thus the circulating current of the E layer formed with two overlapped pulses is 3000 A. The diamagnetic strength is 7%. No additional losses or reduction of the trapping efficiency were observed in stacking the second pulse. A new feature of the Astron facility is the addition of a toroidal field generated by a pulsed axial current along the axis of the Astron solenoid. The presence of a weak toroidal field during the electron injection provides enough focusing to remove the threshold of stable precessional oscillations. Since in the presence of a toroidal field the precessional oscillations are always stable, it is possible to trap the E layer in deeper mirror field (e.g., 14% instead of 8 to 10%). A stronger toroidal field during injection ($B_\theta \approx B_z$) provides axial focusing of the injected electron bunch, resulting in improved trapping efficiency by about three-fold. In single-pulse injection, trapped E layers of circulating current of 4000 A and diamagnetic strength of 15% were observed. Finally, a strong toroidal field increasing in time applied after the E layer trapping compresses the length of the E layer. A toroidal field equal to 60% of the poloidal guiding field compresses the E layer length by approximately a factor of two. (auth)

38492 (CONF-710607-12) APPLICATION OF INTENSE RELATIVISTIC ELECTRON BEAMS TO ASTRON-TYPE EXPERIMENTS. Andrews, M. L.; Davitian, H.; Fleischmann, H. H.; Kribel, R. E.; Kusse, B. R.; Nation, J. A. (Cornell Univ., Ithaca, N. Y.); Lee, R.; Lovelace, R. V.; Sudan, R. N. (Naval Research Lab., Washington, D. C.). 17 Jun 1971. 21p. (CN-28/A-11). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Due to recent advances in high-voltage pulse technology, high-current electron beams of several hundred kA and up to a few MeV became available for fusion research over the last few years. In addition to possible applications to plasma heating, these beams may be useful for production of relativistic-electron current layers. Typical beams contain considerably more electrons than needed for an Astron experiment. The relatively poor angular beam divergence can be balanced by the focusing magnetic self-fields of the beam. Small-scale experiments were performed using the pulsed high-voltage facility at Cornell. Electron beams of 10 to 30 kA having energies of 300 to 400 keV and an angular divergence of a few degrees were injected into magnetic fields of 200 to 300 gauss, the injection angle ranging from 75 to 85°. To provide space-charge neutralization, air pressures in the range 0.2 to 1 torr were maintained in the field region. When injecting into a homogeneous magnetic field, optical observation shows the beam to remain self-focused and to propagate in spirals along the field lines approximately corresponding to the average electron energy and injection angle. Also, reflection from a mirror and partial trapping between two mirrors bracketing the injector is observed. Well-shielded magnetic probes on the field axis indicate diamagnetic field changes of up to 40% of the original field when injecting into a homogeneous field. In the double-mirror arrangement, field changes of up to 140%, i.e., actual field reversal are observed. The radial distribution of the magnetic field indicates a thickness of the current layer of the same order as the radius. Due to the presence of the injector, the relativistic electrons were lost rapidly. Experiments on the trapping in regions separate from the injector and on the influence of pre-ionization on the beam behavior are discussed. (auth)

38493 (CONF-710607-26) OAK RIDGE TOKAMAK RESEARCH. Barnett, C. F.; Clarke, J. F.; Davis, R. C.; Dory, R. A.; Edmonds, P. H.; Forsen, H. K.; Hogan, J. T.; Kelley, G. G.; Lubin, M. J.; McNally, J. R.; Morgan, O. B.; Murakami, M.; Roberts, M.; Soures, J. M.; Stewart, L. D.; Stirling, W. L.; Widner, M. M. (Oak Ridge National Lab., Tenn.). 17 Jun 1971. 14p. (CN-28/C-1). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Research related to the experiment ORMAK is described. The behavior of Tokamak discharges was studied using two-fluid MHD theory augmented where necessary and possible by specific experimental features (banana orbits, impurities, external circuits, etc.). Time-dependent spatially resolved integration of the ion and electron heat flow equations and Maxwell equations (as in work by Dnestrovskii et al.) has given data for experimental comparison, for determination of poorly known parameters (resistivity and electron thermal conductivity anomalies, etc.), and for study of sensitivity to parameters normally not adjustable in experiments (scaling laws). The pressure-balance equation is used with these results to determine overall plasma diamagnetism. The ORMAK experiment is designed to go well into the collisionless (banana) régime where a reactor would operate. In this régime, the effect of asymmetries could be quite harmful so they have been minimized by careful design. Parameters are R = 80 cm, r_p = 23.5 cm, and A = R/r_p = 3.4. Total currents of 400 kA (programmable) will eventually be available to give q (safety factor) = 1.5 at the maximum toroidal field of 25 kG. A programmable vertical field is provided for positioning the plasma. At 400 kA, the theory predicts $T_e \sim 2$ keV and $T_i \sim 1$ keV at $n = 5 \times 10^{13}$ cm^{-3}. Initial results from this device are described, including space- and time-resolved laser measurements of electron temperature and density and charge-exchange measurements of ion temperature. These measurements will be correlated with computed values to determine transport coefficients. Magnetic probes were used to study mode patterns of instabilities and movement of the plasma column. (auth)

38494 (CONF-710607-36) STRUCTURE OF THE DENSE PLASMA FOCUS. PART I. NUMERICAL CALCULATIONS, X-RAY, AND OPTICAL MEASUREMENTS. Gratreau, P.; Luzzi, G.; Maisonnier, Ch.; Pecorella, F.; Rager, J. P.; Robouch, B. V.; Samuelli, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratorio Gas Ionizzati). 17 Jun 1971. 11p. (CN-28/D-1). Dep. NTIS (U. S. Sales Only).

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From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Preliminary results of numerical calculations are presented. They are based upon the application of Potter's code to a particular DPF geometry. The implosion phase, the radial oscillations of the plasma, and the axial drift of constant density profiles in the plasma column are studied. The electron temperature is determined by detecting simultaneously the continuum x-ray radiation passing through different filters. Using a new diagnostic tool, recently developed in Frascati, consisting of a channel multiplier array associated with a conventional image-converter camera, x-ray framing pictures with 10 ns exposure time are obtained. They allow an evaluation of the hot plasma location and dimensions. Correlations between neutron and x-ray emissions are discussed. The optical emission during the compression phases is recorded by an image-converter streak camera observing the axial region through a 100-μ slit parallel to the axis. In this way the radial oscillations and the axial motion of the plasma are studied. A new diagnostic method is proposed. It allows the simultaneous determination of both the electronic temperature and density using time-resolved, relative, spectroscopic measurements on suitably chosen impurities lines. The characteristics of this method are described. (auth)

38495 (CONF-710607-37) STRUCTURE OF THE DENSE PLASMA FOCUS. PART II. NEUTRON MEASUREMENTS AND PHENOMENOLOGICAL DESCRIPTION. Maisonnier, Ch.; Gourlan, C.; Luzzi, G.; Papagno, L.; Pecorella, F.; Rager, J. P.; Robouch, B. V.; Samuelli, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratorio Gas Ionizzati). 17 Jun 1971. 10p. (CN-28/D-2). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Neutron measurements carried out on the DPF facility at Frascati are described. These measurements are done using nuclear emulsions, activation counters, and scintillators coupled to photomultipliers. The neutron flux anisotropies are measured with a precision better than 2%, and reported energy spectra correspond to neutrons emitted in a single discharge. The results obtained lead to the exclusion of the applicability of simple models in interpreting the DPF, but are consistent with a proposed phenomenological model consisting of a combination of a moving boiler with a beam–target. The experimental results relative to x-ray, optical, and neutron measurements, as well as to the preliminary results of numerical computations, are discussed, and the evaluation of certain plasma parameters is given. (auth)

38496 (CONF-710607-38) MEASUREMENTS OF THE PLASMA CONFINEMENT AND ION ENERGY IN THE DENSE PLASMA FOCUS. Peacock, N. J. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.); Hobby, M. G. (Leicester Univ. (England)); Morgan, P. D. (Royal Holloway Coll., Englefield Green (England)). 17 Jun 1971. 14p. (CN-28/D-3). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The structure and velocity of the plasma boundary during the implosion phase of the dense Plasma Focus was studied using repetitively pulsed, 1 nsec exposure, transmission photography with spatial resolution of 100 microns. Both acceleration and deceleration of the plasma boundary are observed by shadowgram and schlieren photography. Long-wavelength, Rayleigh–Taylor instabilities grow on the boundary during its acceleration. On subsequent deceleration, a singularly steep density gradient is observed transiently on the axis of symmetry and has dimensions smaller than any other plasma parameter except for collision-free skin depth. The density distribution, approximately parabolic with a maximum on the axis of symmetry when the pinch is well-developed, is derived directly from interferograms. Local breakup of the pinch takes place, often due to m = 0 and, less commonly, m = 1 instabilities. The sustainment time of the pinched plasma is not more than 50 nsec and corresponds directly with the initial burst of thermal x rays. No correlation of the refractive index gradients could be found with the later double and triple pulses of soft x rays (and neutrons), which in some instances are emitted 200 nsec after the first pulse, and this implies the existence of a more tenuous plasma ($n_e < 8 \times 10^{18}$ cm^{-3}) at this time. The ion energy distributions, transverse to the axis of symmetry, of several ion species of argon and neon were measured using high-resolution, x-ray spectroscopic techniques. The ions have a thermal energy distribution with a mean energy of about 9 keV. These results, in addition to the deuterium ion temperature estimated from the neutron emission, are interpreted as giving a scaling law for the transverse energy $E_{Z/M} = T_0(1 + Z^2/M)$, where T_0 results from compression and resistive heating and the remainder may be due to weak turbulence. Dielectronic recombination is responsible for the Li-like ion satellites and has to be taken into account to explain the intensity and the time of appearance of the line emission. (auth)

38497 (CONF-710607-40) RECENT STUDIES OF DENSE PLASMA FOCUS. Mather, J. W.; Bottoms, P. J.; Carpenter, J. P.; Ware, K. D.; Williams, A. H. (Los Alamos Scientific Lab., N. Mex.). 17 Jun 1971. Contract W-7405-eng-36. 13p. (CN-28/D-5; LA-DC-12248). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Empirical solutions to the problems of restrike or subsidiary breakdown in the breech of the plasma focus accelerator were found for 50-kV operating voltages. Restrike during the acceleration phase has plagued focus experiments because its occurrence actually short circuits the capacitor energy from the current sheath. Quality control of the Pyrex insulator, electric flux control at the center electrode surface, and lower electric fields across the inter-electrode space are effective measures reducing restrike. The transition from the inverse pinch to the axial rundown phase as well as the fraction of time taken up by the inverse stage relative to the quarter period are of concern. These and other dynamical aspects are discussed. There seems to be no single or simple plasma mechanism that can account entirely for the rapid heating of ions and electrons in the plasma focus. Neutron production continues, on the average, to scale as I^4, and the neutron flux ratios at 0°/90° vary from 1.1 to 1.7 under high-voltage operation. Peak D–D neutron yields of $\sim 3 \times 10^{11}$/discharge were achieved at 50 kV, 120 kJ. X-ray-absorption measurements previously made with DPF III (25 kV, 100 kJ) suggest, by and large, a thermal kT spectrum with electron temperatures of 3 to 4 keV; the precise contribution of line radiation is not known; however, the total photon energy above 40 keV is <5%. X-ray spectra, obtained on a single discharge with multiple K absorption vacuum diodes (variable Z cathodes) and selective filters are discussed. The relevance of impedance considerations to good plasma focusing cannot be overemphasized. In this respect, high-voltage operation and high capacitor bank impedance, relative to the plasma focus impedance, are necessary conditions for large discharge currents per joule stored energy. The application of the swinging Marx circuit in the plasma focus system, DPF VI (50 kV, 214 kJ), shows a convenient and practical method of obtaining power sources at least up to 100 kV. (auth)

38498 (CONF-710607-41) EXPERIMENTAL AND THEORETICAL INVESTIGATION OF A GAS DISCHARGE OF THE PLASMA FOCUS TYPE. Agafonov, V. I.; Belyaev, I. F.; Vikhrov, V. V.; Golub, G. V.; Golubchikov, L. G.; D'yachenko, V. F.; Ivanov, V. I.; Imshennik, V. S.; Moiseeva, M. P.; Svirskii, E. B.; Filippova, T. I.; Filippov, N. V. (Institut of Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 34p. (In Russian). (CN-28/D-6). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The development of the high-current gas discharge (of the "plasma focus" type) accompanying the noncylindrical compression of the z pinch is discussed. In addition to the usual operating regimes, with uniform filling of the chamber with deuterium, variants involving a complex gas density profile are tried. Considerable attention is paid to the influence of impurities in the form of heavy atoms on the progress of the discharge. The principles underlying the increase in neutron yield as a function of capacitor bank energy and working gas composition are determined. Machine calculations were made of the motion of the plasma sheath when there are wide variations in the initial conditions and the electrotechnical characteristics of the discharge circuit. X-ray emission from a plasma focus was studied and frame-by-frame photographs of the pinch through a thin aluminum filter with an exposure of about 30 ns were made. The emission spectra of strongly ionized impurity atoms deliberately introduced into the plasma focus were studied theoretically and experimentally. Calculations were made of a two-dimensional magnetohydrodynamic model of the pinch effect with allowance for finite electric conductivity, viscosity, and heat conductance, together with the time dependence of the total current. The plasma dispersion coefficients are assumed to be coulombic and isotropic. The problem is solved by the free-point method, the initial conditions and electrotechnical parameters of the device being the same as in the earlier calculations (i.e., for W = 50 kJ). While the parameters of the first compression virtually coincide with the results of the preceding calculations, results similar to those observed in the experiments were obtained for the second, more-powerful compression (which had previously taken place without interruption). The second compression begins approximately 200 ns after the first and has the following parameters: $T_{max} \approx 1.5$ keV, density $\rho_{max} = n/h_0 \approx 500$; $r_{min} \approx 1$ mm; and $\Delta Z \approx 5$ mm. (auth)

38499 (CONF-710607-42) MECHANISM OF PLASMA FOCUS FORMATION IN A COAXIAL INJECTOR. Burdonskii, I. N.; Vasil'eva, R. P.; Pergament, M. I.; Yaroslavskii, A. I. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 14p. (In Russian). (CN-28/D-7). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The mechanisms involved in the formation of a focus and the heating of the plasma therein are discussed. It is established that almost the entire current shorts through the fairly thin moving current layer only in the first, relatively short stage of the process. In the second stage, the current is at first distributed comparatively uniformly through the entire plasma volume; it then shorts at the rear end of the plasma gun, forming a current eddy. In the longitudinal sectional view of the electrode gap, the eddy-current lines look like nested ovals extending along the electrodes and projecting in the forward part beyond the electrode system. With time, the rear boundary of the current eddy shifts, together with the plasma, in the direction of acceleration, while the forward boundary of the current distribution remains stationary. The radial equilibrium of the current eddy depends on the fact that the forces $\vec{j} \times \vec{H}$ acting in that part of the current loop in which the current lines are almost parallel to the electrode system are balanced by the pressure gradient. The latter is due to the nonuniformity of Joule heating of the plasma in the current loop, as the current density is zero at the center of the electrode gap and rises sharply as the electrodes are approached. The topography of the magnetic and current fields at the end of the electrode system is such that the forces $\vec{j} \times \vec{H}$ acting in the thick-current distribution layer focus a significant part of the plasma flowing through the electrode gap at the axis of the system in front of the central electrode. These same forces accelerate the plasma from (5×10^6) to (1×10^7) cm/s in the electrode gap to (2 to 3) $\times 10^7$ cm/s in the zone adjacent to the focus. The process is quasi-stationary in the sense that the characteristic times of variations in the compression zone parameters are substantially greater than the time of plasma renewal in the compression zone. In the focus zone $nk(T_e + T_i) \gg H^2/8\pi$; in other words, compression is the result of inertial motion of the plasma fluxes formed in the electrode gap. On the basis of magnetic field, density field, and temperature measurements, a numerical integration was made along the trajectories and the configurations of the plasma fluxes were established. Conditions in the electrode gap under which the described mechanism is transformed into a mechanism whereby a focus is formed by the thin current layer that collects the gas are discussed. (auth)

38500 (CONF-710607-81) STATIONARY TOKAMAK. Kadomtsev, B. B.; Shafranov, V. D. (Institut Atomnoi Energii, Moscow (USSR)). 17 Jun 1971. 14p. (In Russian). (CN-28/F-10). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The basis for plasma confinement in a Tokamak is the longitudinal current induced by the eddy electric field. The lifetime of the eddy electric field is virtually always limited. This is usually considered a disadvantage of the Tokamak system from the point of view of constructing a thermonuclear reactor. The possibilities of noninductive maintenance of a longitudinal current, which would in principle make it possible to construct a stationary thermonuclear reactor on the basis of the Tokamak system, are discussed. To maintain a longitudinal current it is necessary to move the field lines of the poloidal magnetic field out towards the periphery of the plasma column. The possibility of doing this is easily demonstrated in principle by taking, as an example, a cylindrical plasma column without longitudinal magnetic field and inducing artificially a flow of matter and energy along the radius. However, it is impossible to induce such a flow in a straight system when there is a strong longitudinal magnetic field. In a toroidal plasma column it is possible to establish a process whereby the current is maintained by the plasma flow. The conditions under which this is possible and the mechanisms involved in maintaining a stationary current in a plasma by means of external electromotive forces are discussed. (auth)

38501 (CONF-710607-126) EXPERIMENTAL AND COMPUTATIONAL INVESTIGATIONS OF THE DIRECT CONVERSION OF PLASMA ENERGY TO ELECTRICITY. Moir, R. W.; Barr, W. L.; Freis, R. P.; Post, R. F. (California Univ., Livermore. Lawrence Radiation Lab.). 13 May 1971. 20p. (CN-28/K-1; UCRL-72879). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Studies of direct conversion of plasma energy to electricity show that efficient direct conversion would permit a considerable improvement in the power balance in mirror machines. The use of fuel cycles having a high fraction of charged reaction products, such as the D-^{3}He fuel cycle is suggested. Energy is recovered from mirror end losses by expansion in static magnetic fields (to convert perpendicular energy components to parallel), separation of ions from electrons, and, finally, deceleration and selective collection of the particles after each has lost most of its original kinetic energy. Analysis indicates that overall efficiencies of about 90% might be attainable. The heart of the converter is the structure within which deceleration and collection take place. In the system being investigated, the energy-dependent focusing property of periodic electrostatic lenses aids the separation. Computer-derived designs were tested in scaled laboratory experiments, in which variable-energy ion beams were used to study a 22-cell collector system in detail. Under one set of operating conditions the measured efficiency averaged at constant current density over a range of 2 in energy was 88%, whereas computer-simulation calculations for the same case gave 92%; the ideal theoretical maximum efficiency under these conditions would be 97%. Implicit in obtaining the observed efficiencies was the assumption that "retrograde" particles (a few percent of the total) would in practice be re-reflected by the mirrors, be returned to the collector system, and be captured on their second try. If these assumptions had been invalid, the observed efficiencies would have dropped to 83%. Designs aimed at minimizing retrogrades are under investigation. While ultimate limits on power will be set by space charge, computer studies of this problem already indicate (scaled) power values roughly compatible with reactor requirements. Further work to optimize the collector efficiency in the presence of space charge is indicated. A second aspect of direct conversion, also of importance for reactors with neutral beam injection, is the recovery of energy from unconverted and untrapped beams in the injectors. Experiments with 2-keV ion beams have yielded recovery efficiencies as high as 95% at low-power densities. (auth)

38502 (CONF-710607-127) ENGINEERING AND ECONOMIC ASPECTS OF MIRROR MACHINE REACTORS WITH DIRECT CONVERSION. Werner, R. W.; Carlson, G. A.; Lee, J. D.; Moir, R. W.; Post, R. F.; Taylor, C. E. (California Univ., Livermore. Lawrence Radiation Lab.). 20 May 1971. 27p. (CN-28/K-2; UCRL-72883). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Reactor design studies, based on the use of mirror confinement zones fed by neutral beam injectors and utilizing direct converters for charged-particle energy recovery, are presented. Designs considered include Yin-Yang and axially symmetric coil configurations, DT and D^{3}He fuel cycles, and net electrical outputs ranging from 100 to 1000 MW, the latter being the base case. The operating power level of each reactor component is determined as a function of component efficiencies, Q (defined as the ratio of fusion power to trapped injected power), and other relevant variables. Then approximate cost-power scaling relationships are used to calculate component costs. Results for overall cost and system efficiency are presented as functions of Q for a variety of component efficiency sets. The results indicate that the DT system with direct conversion is economically attractive for expected Q values and component efficiencies. In comparison, the D^{3}He system is characterized by high sensitivity to system changes at expected Q values, and very high component efficiencies are required in order to make it economical. The disadvantage of the DT system is that it is basically a heat engine and has little potential for overall system efficiencies greater than 45% at blanket temperatures usually considered. In contrast, D^{3}He has a potential for operating economically at system efficiencies greater than 80%. Such a system could be achieved if Q values for D^{3}He near unity become possible and sufficient ingenuity in the design of efficient reactor components is realized. (auth)

38503 (CONF-710607-128) EFFICIENT RECIRCULATION OF POWER IN MIRROR REACTORS. Cordey, J. G.; Marcus, F. B.; Sweetman, D. R.; Watson, C. J. H. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 20p. (CN-28/K-3). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A model of a mirror reactor system was developed that permits the overall cost of the system to be minimized with respect to the mirror ratio, mirror magnetic field, and injection energy. The model is based upon calculations of the maximum β and the density distribution of the plasma and incorporates a number of assumptions about limiting technological parameters and costs. Both minimum-B and simple mirror systems and both D-T and D-^{3}He fuel cycles were considered. Using the best present estimates of Q, the D-^{3}He reactors are found to be considerably more expen-

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sive than the D–T systems. The use of a simple mirror system reduces the nuclear "boiler" component of the costs by a factor of about two. The minimum overall cost is found to occur when the mirror ratio is such that the maximum wall-loading criterion and maximum-β criterion are simultaneously satisfied and the optimum mirror fields are comparatively modest (in the range 140 to 180 kG). The optimum cost is found to be rather insensitive to the maximum permissible wall loading and to the mirror magnetic field. However, the cost is sensitive to the injection energy (optimum being ~100 keV), and there is a considerable cost penalty in working at energies at which external recirculation schemes become practicable. In order to avoid these high injection energies, a new mirror reactor geometry is proposed that employs direct neutralization and reinjection of the flux of ions escaping through the mirrors. This scheme uses the fact that the particles emerge through the mirrors with their velocity vector nearly perpendicular to the field lines; they are then reinjected with high efficiency in a re-entrant axisymmetric mirror trap. Such a system would operate at low energy (e.g., ~100 keV) and can approach the self-sustaining condition. (auth)

38504 (CONF-710607–129) ON THE ECONOMIC FEASIBILITY OF STELLARATOR AND TOKAMAK FUSION REACTORS. Gibson, A.; Hancox, R.; Bickerton, R. J. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 19p. (CN–28/K-4). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Studies were made of model designs of stellarator-type fusion reactors. These serve to highlight key technological and plasma physics problems that require solution. The basic conflict is between estimates of the critical β for equilibrium and stability and the cost of high magnetic fields from superconducting multipolar coils. The effect of diffusion-driven currents on the critical β and the effect of electric fields on estimates of the cross-field diffusion rate are considered. The inclusion of a 1.5-m blanket in a system with a short-range multipolar field makes it difficult to achieve economic operation in small sizes. However, the unit cost for this type of reactor falls rapidly with increasing size. Thus, if present estimates for the critical β can be realized and if low cost superconductors can be developed, a 10,000-MW(e) stellarator reactor is expected to meet target economic costs, which include a penalty for the large size. (auth)

38505 (CONF-710607–130) FAST NEUTRAL INJECTION FOR PLASMA HEATING AND REACTOR START-UP. Sweetman, D. R.; Riviere, A. C.; Cole, H. C.; Thompson, E.; Hammond, D. P.; Hugill, J.; McCracken, G. M. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). 17 Jun 1971. 17p. (CN–28/K-5). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The injection of fast neutral atoms for the heating of toroidal reactors is considered. The requirement for fast deuterons to penetrate into the plasma volume necessitates an energy of the order of 1 MeV. The basic energy-transfer rates from the trapped particles are shown to be adequate, though the energy reaches the plasma ions mainly via the electrons unless $E_0 \lesssim 70\ T_e$ (where E_0 is the energy of the incident particles). The use of injected beams of high atomic mass does not appear to offer a significant advantage if the beam penetration is fixed. The startup requirements are considered for a typical 7000-MW(th) toroidal reactor system. Because of the basic scaling of diffusion rate with temperature, less than 100 MW is required to reach ignition. This power is, for convenience, divided into 10-MW units and the constraints on the design of one such unit are considered. Basic ion source and accelerator considerations lead to the likely further subdivision of the beam during the early acceleration stages. The low efficiency for neutralization precludes the use of a D^+ primary beam. Various other possibilities are considered, including D_2^+, D_3^+ and D^-. The power efficiency for D_2^+ and D_3^+ is of the order of 20%, and this results in severe, though not insuperable, problems of beam dumping, vacuum, and cost of power supplies. The power efficiency for D^- is in the range 65 to 90% and the above problems are much less serious. The use of the Hall accelerator as an alternative ion source is considered. Hall accelerators have been operated at potentials up to 20 kV and measurements of current output, efficiency, and divergence are presented. (auth)

38506 (CONF-710607–131) EFFECT OF FUSION REACTIONS ON THE OPERATION OF THERMONUCLEAR DEVICES. Belikov, V. S.; Kolesnichenko, Ya. I.; Oraevskii, V. N. (Akademii Nauk Ukrainskoi SSR, Kiev. Institut Yadernykh Issledovanii). 17 Jun 1971. 21p. (In Russian). (CN–28/K-7). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

During the operation of thermonuclear devices, fusion reactions result in the occurrence in the plasma of charged particles, the energy of which considerably exceeds the thermal energy of the reacting ions. If the cross section of the device is not too small, these charged particles will not escape from the plasma confinement zone. The question arises how the accumulation of fusion-reaction products affects the equilibrium of the plasma configurations and the transfer processes in them. One of the factors on which plasma confinement depends is the occurrence of an electric field as a result of the relatively large Larmor radius of the ions formed in thermonuclear reactions. The effect of this type on the equilibrium and stability of the plasma configurations is discussed. Another factor influencing plasma stability is the thermodynamic nonequilibrium of the distribution function of the thermonuclear reaction products. This nonequilibrium is the reason for the occurrence of an extensive class of kinetic instabilities that develop in periods much shorter than the characteristic Coulomb collision times. Some of these instabilities can occur even at the start of the operation of the thermonuclear device. The linear stage in the development of the instabilities associated with thermonuclear reactions is analyzed. The nonlinear stage is also discussed, and evaluations are given of the corresponding transfer coefficients. In addition to investigation of the equilibrium and stability of plasma in thermonuclear devices, the possibility of a quasi-stationary operating régime in a thermonuclear reactor is examined. The critical value for the cross section of the high temperature part of the plasma was found, above which the quasi-stationary régime is impossible and auto-acceleration of the thermonuclear reactions occurs. (auth)

38507 (CONF-710607–133) ENGINEERING DESIGN STUDIES ON THE SUPERCONDUCTING MAGNET SYSTEM OF A TOKAMAK FUSION REACTOR. Lubell, M. S.; Gauster, W. F.; Efferson, K. R.; Fraas, A. P.; Long, H. M.; Luton, J. N.; Parker, C. E.; Steiner, D.; Stoddart, W. C. T. (Oak Ridge National Lab., Tenn.). 17 Jun 1971. 17p. (CN–28/K-10). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

A detailed engineering study was made of a superconducting magnet system for a full-scale tokamak fusion reactor. For economic reasons, the main toroidal field must be produced by superconducting coils. Compound conductors with twisted, thin filaments and a sufficiently high copper-to-superconductor ratio to provide both static and dynamic stability were used. Commercial superconductors that satisfy these criteria are NbTi compound conductors. The use of this material restricts for the design the maximum magnetic field strength (which results from the dc main toroidal field and the pulsed poloidal field) to about 80 kG. A total power $P_T = 5000$ MW(th), a wall loading $P_w = 3.5$ MW/m^2, a vacuum chamber minor radius $r_w = 3.5$ m, a pressure ratio $\beta_\theta = 3$, and a stability margin $q = 1.4$ are assumed. These values and the maximum field strength $B_M = 80$ kG yield a toroidal magnetic field $B_\varphi = 37$ kG, a major radius $R = 10.5$ m, a minor coil radius $r = 5.59$ m, and a plasma aspect ratio $A = 3.75$ if one considers a blanket thickness $w = 2$ m and a ratio $y = 0.8$ between plasma and vacuum chamber radii. The stored magnetic energy is about 40,000 MJ and about 1.45×10^6 m of compound conductor is required. The design of the mechanical structure is based on detailed force and stress calculations. The net radial force on each of the 48 coils is 10,580 tons, requiring massive reinforcement of the bobbins. The cryogenic calculations consider all sources of heat loads, and, in the worst case, about 75% of the total loss is due to the nuclear radiation. The structural design takes into consideration the assembly as well as maintenance and repair difficulties arising from radiation damage and neutron activation. Detailed cost estimates were made. The kind of major technological research and development work necessary for optimized realistic designs is summarized. Finally, an economic comparison is given between a 5000-MW(th) and a 1000-MW(th) reactor with the result that, while the magnet system for the latter would cost only 43% as much, the unit cost in $/kW(e) would be about double. (auth)

38508 (CONF-710607–134) EMERGENCY COOLING AND RADIOACTIVE WASTE-DISPOSAL REQUIREMENTS FOR FUSION REACTORS. Steiner, Don (Oak Ridge National Lab., Tenn.). 17 Jun 1971. 13p. (CN–28/K-11). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The emergency cooling and radioactive waste-disposal requirements anticipated for fusion reactors are compared with those requirements posed by fission reactors. A reference fusion reactor is used as the basis for comparison. This reactor is based on the D–T fuel cycle and employs a blanket consisting of nio-

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bium as the structural material, lithium as the coolant, and graphite as the neutron moderator and reflector. Relative to fission reactors, the reference fusion reactor exhibits the following advantages with respect to emergency cooling requirements: (1) a lower hazard potential associated with radioactive inventories, (2) lower nuclear power densities during operation and for many hours following shutdown, (3) no potential for nuclear energy insertions resulting from loss of coolant or meltdown, and (4) a more favorable coolant-passage geometry. The management of radioactive wastes should require fewer operations for fusion reactors than for fission reactors, and therefore, the associated economic penalty should be less. The effects of alternate fusion fuel cycles and alternate blanket structural materials are summarized. Fusion reactors operating on the D–^{3}He fuel cycle would exhibit less-stringent emergency cooling and radioactive waste-disposal requirements than would reactors operating on either the D–T or D–D fuel cycles. Of the several blanket structural materials considered, vanadium has the most desirable characteristics with regard to emergency cooling and radioactive waste disposal. (auth)

38509 (CONF-710607-135) NEUTRONIC AND THERMAL DESIGN ASPECTS OF THERMONUCLEAR FUSION REACTOR BLANKETS. Borgwaldt, H.; Koehler, W. H.; Schroeter, K. E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). 17 Jun 1971. 20p. (CN-28/K-12). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Discrete-ordinate transport theory calculations are presented for the tritium breeding ratio and power-density profiles from neutron and γ heating in the first wall, the blanket, and the reflector of a cylindrical thermonuclear fusion reactor operating on the D–T cycle. Lithium isotopic composition and coolant (Li or flibe) are varied as parameters. Some of the breeding-ratio calculations are checked with Monte Carlo calculations. The results indicate that there should be no problem obtaining adequate tritium breeding, which is optimal at approximately the natural Li isotopic composition. Power densities in structural material are quite high and almost exclusively due to γ heating. Switching from Li coolant to flibe increases the power produced in the blanket by about 15%, while it decreases the tritium breeding ratio between 10 and 20%. (auth)

38510 (CONF-710607-136) BLANKET COOLING CONCEPTS AND HEAT CONVERSION CYCLES FOR CONTROLLED THERMONUCLEAR REACTORS. Foerster, S. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung); Bohn, Th. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Technische Physik). 17 Jun 1971. 17p. (CN-28/K-13). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The neutron energy generated in fusion plasmas produces heat in solid and liquid blanket regions that confine the fusion plasma. This heat has to be removed by cooling the blanket and is then converted into electric energy by thermodynamic processes. Blanket cooling can directly be achieved by cycling the liquid blanket material through an outside cooler, or indirectly, by leading gaseous or liquid coolants through pipes in the blanket. For the heat conversion to electricity, single Rankine or Brayton cycles can be applied, as well as binary Rankine cycles using potassium and steam as cycle fluid. The special features of different systems for blanket cooling and for heat conversion are described and discussed. The thermodynamic requirements for favorable operation of the different heat conversion cycles and those for the heat removal system from the CTR are pointed out. Also, the pumping power in magnetic or nonmagnetic coolant flows is considered. Selected solutions for combining the systems of blanket cooling and of heat conversion are compared with respect to plant efficiency, the lost volume fraction in the lithium blanket region, and the expected constructional and safety features. These comparisons are made for thermal powers of the reactor between 5,000 and 10,000 MW and toroidal configurations. Solutions to be preferred are pointed out. (auth)

38511 (EUR-CEA-FC-580) TECHNICAL STUDY OF A SUPERCONDUCTING QUADRUPOLAR COIL. Asesio, P.; Berruyer, A.; Bronca, G.; Del-Cas, R.; Hamang, M.; Hennion, F.; Tachon, J.; Valckx, F. P. G. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1971. 82p. (In French). Dep. NTIS (U. S. Sales Only).

The technical project of the superconducting coil and cryogenic installation for the experiment of multi-injection of fast neutrals in a quadrupolar coil is presented. The complete experiment is briefly described. (France)

38512 (MATT-Trans-104) NUMERICAL CALCULATION OF THE MAGNETIC FIELD CONFIGURATION IN A TOKAMAK. Bazhanova, A. E.; Shafranov, V. D. (Institut Atomnoi Energii, Moscow (USSR)). Translated for Plasma Physics Lab., Princeton Univ., N. J., from report IAE-2046. 45p. Dep. NTIS.

The distribution of a magnetic field holding a toroidal plasma column with radii α, R, in equilibrium, is calculated in the magnetohydrodynamic approximation. The calculation is performed for the simplest distribution of the longitudinal current $j_\varphi = Ar + B/r$, where A and B are constants characterizing the magnitude of the plasma pressure and its diamagnetism with respect to the longitudinal magnetic field. The following results were obtained. It was demonstrated that, even in the case of a very steep plasma torus with $R/\alpha = 1.5$, the confining magnetic field is close to uniform. The limiting value of the parameter β_l compatible with the condition of confining the plasma and characterizing the ratio of the plasma pressure to the magnetic field pressure of the longitudinal current J was calculated. The depth of the mean magnetic well and the angle of rotational transformation were calculated as functions of the plasma pressure, and it was demonstrated that for a pressure close to limiting the crossing of the force lines increases noticeably. The distribution of the surface current creating the confining magnetic field required for equilibrium and the distribution of the current in the superconducting torus were computed. A calculation of the confining field created by the currents in the given conductors is presented. The calculation results are presented in the form of figures. (auth)

38513 PULSED HIGH MAGNETIC FIELDS. Physical Effects and Generation Methods Concerning Pulsed Fields Up To the Megaoersted Level. Knoepfel, Heinz. New York: American Elsevier Publishing Company, Inc. (1970). 393p. $23.00.

The problems connected with the generation and application of transient magnetic fields extending from the kilo-oersted to the multimegaoersted level with a pulse length of typically less than 0.1 sec are presented in the text. High magnetic fields are being investigated more because they can be produced more easily than continuous ones, and modern time-resolved diagnostic techniques allow work in pulsed operation to be carried out easily. Fields in excess of 200 to 500 kOe are of a transient nature, and are necessary in controlled thermonuclear research. (J.E.W.)

38514 TECHNICAL NOTE ON D-T FUSION REACTOR AFTERHEAT. Dudziak, Donald J. (Los Alamos Scientific Lab., N. Mex.). Nucl. Technol.; 10: No. 3, 391-2(Mar 1971).

The afterheat in a D–T fusion reactor of conventional design is shown to be a serious consideration for loss-of-flow or loss-of-coolant accidents. Some previous estimates by others of the radioactivation of a niobium vacuum wall and structure are shown to be grossly low. The major additional contributions to the afterheat are from ^{94m}Nb, ^{92m}Nb, ^{95}Nb, ^{95m}Nb, and a long-lived metastable state of ^{93}Nb. By considering some of these additional decay sources, the afterheat from a typical 5-GW(th) D–T reactor design is computed to be at least 30 MW. Early in the reactor lifetime, the decay of the afterheat power should be characterized by the 10.1-d half-life of ^{92m}Nb. A qualitative review of the activation cross sections of molybdenum, an alternate possibility as a structural material, does not give expectation of decay powers orders of magnitude lower than niobium. (auth)

Wave Phenomena

38515 (CONF-710607-25) REMOTE PLASMA CONTROL, HEATING, MEASUREMENTS OF ELECTRON DISTRIBUTION, AND TRAPPED PARTICLES BY NONLINEAR ELECTROMAGNETIC INTERACTIONS. Wong, A. Y.; Chen, F. F.; Booth, N.; Jassby, D. L.; Stenzel, R.; Baker, D.; Liu, C. S. (California Univ., Los Angeles). 17 Jun 1971. 9p. (CN-28/B-15). Dep. NTIS.

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

Nonlinear electromagnetic interactions with plasmas are generalized to include excitations at both cutoffs and resonances for extraordinary and ordinary modes of propagation. Experimental confirmations are presented. The collisionless and efficient nature of a "double resonance" scheme, in which high-frequency electron resonant modes couple to low-frequency resonant ion modes, is exploited for plasma control and heating of plasma ions when a direct coupling to ion modes is not feasible. A new method of measuring electron velocity distribution functions at various radii of a fusion plasma is presented in which the cross sections of laser scattering are dramatically increased. Finally, the

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electromagnetic excitation and detection of magnetically trapped particles via the echo technique are examined. (auth)

38516 (CONF-710607-140) RESEARCH ON THE TRANSFORMATION AND ABSORPTION OF HIGH-FREQUENCY WAVES IN A PLASMA, FOR THE PURPOSE OF DEVELOPING METHODS OF PLASMA HEATING. Arkhipenko, V. I.; Berezin, A. B.; Budnikov, V. N.; Golant, V. E.; Novik, K. M.; Obukhov, A. A.; Piliya, A. D.; Fedorov, V. I.; Shakhovets, K. G. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). 17 Jun 1971. 33p. (In Russian). (CN-28/L-4). Dep. NTIS (U. S. Sales Only).

From 4th conference on plasma physics and controlled nuclear fusion research; Madison, Wis. (17 Jun 1971).

The transformation of high-frequency waves introduced into rapidly attenuating longitudinal plasma waves was studied. At the present time the theory of linear transformation of this type is generalized for the case of a two-dimensional inhomogeneous plasma. It was shown that, when account is taken of the inhomogeneity, the transformation must take place in the vicinity of singular points of the concentration constant curves. The characteristics of the transformation in a toroidal magnetic field with shear were investigated. Experiments on the determination of the conditions of wave transformation and absorption were carried out in a homogeneous magnetic field (the 3- and 10-cm bands were used). For the determination of the transformation region, a method of local perturbation (lengthwise) was applied. A weak perturbation of the magnetic field in the region of the transformation led to a sharp reduction in absorption. The study of this effect, together with measurements of the concentration distribution, permitted a comparison of data on the transformation conditions with non-one-dimensional theory. With the help of probes, an investigation was carried out of the amplitude distribution of an ultra-high-frequency field in the region of wave transformation and absorption (at frequencies close to the upper hybrid). On the basis of these data, it is possible to determine the localization of the transformation region, to establish the propagation region of the plasma waves formed as a result of transformation, and to assess the effectiveness of their damping (particularly in the vicinity of the electron cyclotron frequency harmonics). For absolute measurements of the amplitude of the uhf field in the plasma-wave transformation and propagation region, the Stark broadening of the hydrogen lines was measured. At the present time preparations are being made for experiments on the determination of the wave-absorption conditions in the toroidal magnetic trap, Tokamak-2, which has a minor radius of 17 cm and a magnetic field of up to 10 kOe. With this unit it is intended to obtain data on the wave-absorption spectrum in the frequency range from upper to lower hybrid. (auth)

38517 (EUR-CEA-FC-577) STUDY OF GUIDED ELECTROMAGNETIC WAVES PROPAGATING THROUGH A VACUUM CHANNEL IN A PLASMA. Rizk, H. M. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan 1971. 18p. Dep. NTIS (U. S. Sales Only).

Nonaxially symmetric guided electromagnetic waves propagating along a cylindrical vacuum channel in an unbounded magnetoactive cold uniform plasma are investigated. The equations of the electromagnetic field and the rate of damping of the surface waves are derived. Several specific cases are considered: (1) an anisotropic plasma in finite, infinite, or very strong magnetic fields, (2) an isotropic plasma, and (3) the quasi-static approximation. (auth) (France)

38518 (NP-18895) CIRCUITS FOR STUDYING INTERACTIONS OF HIGH-FREQUENCY FIELDS WITH PLASMA IN LINEAR INSTALLATIONS. Savchenko, I. S.; Yampol'skii, I. R. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). 1970. 27p. (In Russian). Dep. NTIS (U. S. Sales Only).

Circuit diagrams are given for forming high-frequency fields in plasma experimental installations with cylindrical discharge chambers. The structure of transverse rotating fields with various number of poles (p = 0, 1, and 2) is discussed. The structure consists of eight rods distributed uniformly along the generating cylinder, which are attached separately to the capacitor bank according to the scheme of a simulated delay line enclosed in a ring or as a separate magnetically coupled circuit. The suggested schemes can be excited by a four-phase voltage source, which results in highly symmetric fields. The circuits can be excited simultaneously at two frequencies. Moreover, each frequency matched to a specific pole number p. Formulas were obtained for determining the main parameters, and some data are given for practical implementation of the circuits. (tr-auth)

38519 NONLINEAR THEORY OF PROPAGATION OF ELECTROMAGNETIC WAVES IN THE PLASMA OF A SOLID BODY AND OF A GASEOUS DISCHARGE. Bass, F. G.; Gurevich, Yu. G. (Inst. of Radiophysics and Electronics, Kharkov). Usp. Fiz. Nauk; 103: No. 3, 447-68(Mar 1971). (In Russian).

Nonlinear effects of propagation of electromagnetic waves arising in a plasma and their dissipation are discussed. Cases are examined in which nonlinear normal and abnormal spin effects occur during weak attenuation of the electromagnetic wave when nonlinearity is weak, as well as during severe nonlinearity. Wave amplitude and temperature of the carrier depend on the coordinates and the coefficient of reflection. Cases were investigated in which the carrier temperature was an undefined function of wave amplitude. The coefficient of reflection thus becomes an oscillating function of the amplitude of the incident field. (tr-auth)

38520 LOW-FREQUENCY WAVES ON A POSITIVE COLUMN IN A MAGNETIC FIELD. Duncan, Alan James. Stanford, Calif.; Stanford Univ. (1970). 124p. University Microfilms Order No. 71-12,888.

Thesis.

In planar geometry, Timofeev and Self have shown that two instabilities are to be expected for wave propagation almost perpendicular to B_z. One of these, the ion-acoustic instability, corresponds approximately to a disturbance propagating at the ion-acoustic speed. The other, the drift instability, propagates close to the diamagnetic drift speed, and only occurs when the effect of B_z on the ions is important. In a cylindrical positive column, waves may experience simultaneously the destabilizing effects of Hall, diagmagnetic and axial drifts, and theories which take these drifts into account are required. For the description of an experimental positive column it is consequently important to consider the steady-state conditions on which the waves are superimposed, and to take account of boundary conditions correctly. The three main theories aimed at doing so are those of Kadomtsev and Nedospasov (KN), Johnson and Jerde (JJ) and Ewald, Crawford and Self (ECS). The present work shows that the ECS theory, which includes ion inertia but neglects the effect of B_z on the ions, predicts the high frequency ion-acoustic instability in low B_z whereas the JJ theory, which neglects ion inertia but includes the effect of B_z on the ions, predicts the lower-frequency drift instability in higher B_z. The KN theory is shown to be the asymptotic limit for the ECS and JJ theories at higher pressures where the ion motion is collision-dominated. (TSS) (Diss. Abstr. Int., B)

38521 RECIPROCAL TRANSFORMATION OF MAGNETOHYDRODYNAMIC WAVES IN A HOMOGENEOUS PLASMA IN A FIELD DEPENDENT ON A SINGLE CO-ORDINATE. Zoler, D.; Maxim-Gazi, R. (Centre de Recherches de Physique, Iasi). Physica: 52: No. 2, 246-52(31 Mar 1971). (In French).

The situation considered is characteristic of the upper layers of the atmosphere and discharge tubes. From the dispersion equation for the coupled magnetohydrodynamic waves, two kinds of waves are obtained in such a plasma: a wave of the modified Alfvén type and one of the acoustic type. The waves are coupled due to magnetic fields, which are inhomogeneous. The indices of refraction for the two waves prove to be complex, indicating an attenuation of the amplitude of the waves. The conditions of stability for each wave are also obtained. Finally, the so-called "coupling indices" are calculated, which permit the deduction of the reflection conditions and the conditions for the generation of waves. It is concluded that the Alfvén waves are more stable than the acoustic waves. (auth)

38522 STIMULATED WAVE SCATTERING AND PLASMA HEATING BY COHERENT RADIATION. Litvak, A. G.; Trakhtengerts, V. Yu. (Gorky Radiophysical Inst., USSR). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1702-13(May 1971). (In Russian).

A method for investigation of nonlinear interaction between quasi-monochromatic waves in a plasma is developed. The features of stimulated scattering of coherent high-frequency radiation in the kinetic hydrodynamic stages are analyzed. The possibility of using scattering processes for collisionless heating of a plasma is considered. (auth)

Shielding

Refer also to abstracts 37612, 37769, 37943, 38856, and 38857.

38523 (BNWL-1551(Pt.2), pp 80-5) RADIATION DOSIMETRY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

In Pacific Northwest Laboratory annual report for 1970. Volume II.

Measurements were completed of ionization distributions produced by fine beams of protons in wall-less proportional counters which simulate small biological sites. Definitive data were ob-

tained for 1.7-, 3.0-, and 4.0-MeV protons, and results are given here for 3.0-MeV protons passing a 25 $\mu g/cm^2$ site at various distances from the center. An extension of hit theory to help explain radiobiological effects due to repair or recovery is briefly reported; results of a Monte Carlo evaluation of P_n, the probability of surviving n hits, are given. (L.M.T.)

38524 (BNWL-1551(Pt.2), pp 86-9) RADIATION PHYSICS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).
In Pacific Northwest Laboratory annual report for 1970. Volume II.

Doubly-differential electron ejection cross sections for fast protons in gases were analyzed to give the total ionization cross section and mean kinetic energy of first generation secondary electrons (FGSE) in an ionizing event. For fast protons in molecular hydrogen gas, the fraction of the total stopping power that goes to overcome the binding energy of the ionization electron is about 0.33 for 100-keV protons and decreases monotonically to approximately 0.21 at 2 MeV. The fraction of the stopping power carried away as kinetic energy by FGSE increases from 0.56 to about 0.65 over the same proton energy range. (M.H.R.)

38525 (EGG-1183-1467) ATTENUATION OF 5.9 keV PHOTONS BY HELIUM AND HYDROGEN. Tech Report No. L-976. McCrary, J. H.; Looney, L. D. (EG and G, Inc., Las Vegas, Nev.); Atwater, H. F. (Los Alamos Scientific Lab., N. Mex.). 6 Feb 1970. 7p. Dep. NTIS.

The narrow-beam attenuation coefficients of helium and hydrogen were measured at 5.895 keV. A K_β filtered ^{55}Fe source of Mn x rays, a set of collimators, and a low-energy sodium iodide counter were used with a high-pressure gas chamber. Photon intensities were measured with and without gas in the chamber. The measured coefficients are 0.416 ± 0.017 cm^2/g for He and 0.400 ± 0.016 cm^2/g for H_2. These numbers are compared with theoretical predictions of this parameter. (auth)

38526 (KFK-1369) SPECIFIC ENERGY LOSS AND EFFECTIVE CHARGE OF FISSION PRODUCTS IN METAL ABSORBERS. Albrecht, Helmut (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Mar 1971. 61p. (In German). Dep. NTIS (U. S. Sales Only).

The specific energy loss of fission fragments was measured by placing different Al, Ni, Ag, and Au foils between a ^{252}Cf fission source deposited on an extremely thin backing and a semiconductor detector. The thickness range of the foils was 0.1 to 2.0 mg/cm^2. By using a second detector, placed on the reverse side of the fission source, it was possible to measure the energy as well as the mass of the fission fragments. The energy and mass ranges covered were 0.4 to 1.1 MeV/amu and 90 to 150 amu, respectively. The results were compared with the experimental data of Moak and Brown, Kahn and Forgue, Kalish et al., and of Müller and Gönnewein. Furthermore, the applicability of a semiempirical formula of Münzel was examined. To the equation for dE/dx of Lindhard et al., a correction factor was added, which depends on the nuclear charge of the fission fragments. The effective charge Z_{eff} was determined by deflection of the fragments in a magnetic field. This measurement was carried out in order to investigate whether or not Bohr's classical theory might be applied to the slowing down of the fission fragments. The result was that the equation of Bohr does not hold, even when the shell correction terms are considered. The calculation of the effective charge for gaseous absorbers can be carried out using the Thomas-Fermi model of the atom. This is shown by application of a formula of Sommerfeld based on this model. In the case of solid absorbers, one is restricted to empirical formulas because the influence of the density effect is not yet calculable. One of these formulas, which was proposed by Leischner, is verified by the results of the measurements. (auth)

38527 (UCRL-20291) TECHNIQUES FOR MAPPING THE SPATIAL DISTRIBUTION OF STOPPING π^- MESONS IN TISSUE. Sperinde, J.; Temple, L. E.; Perez-Mendez, V.; Miller, A. J.; Rindi, A. (California Univ., Berkeley. Lawrence Radiation Lab.). 3 Mar 1971. Contract W-7405-eng-48. 16p. Dep. NTIS.
A number of processes leading to the emission of photons and neutrons in π^- capture reactions are discussed for potential use in radiation therapy to determine the stopping π^- region. It is concluded that the scheme of detecting collimated medium-energy γ rays is the most effective. (auth)

38528 EFFECTS OF SPATIAL PERTURBATIONS ON PARTICLE TRANSPORT IN OTHERWISE HOMOGENEOUS MEDIA. Lichtenstein, Henry. New York; Columbia Univ. (1970). 115p. University Microfilms Order No. 71-6212.
Thesis.
A method is developed for the analysis of particle transport problems where the solution of primary interest emphasizes a localized region far from the source. Two major obstacles to a direct Monte Carlo treatment of such problems are the complex geometry and the statistics of the computation. This dual complexity suggests an alternative procedure that envisions a decomposition of the given problem into two related problems. Each related problem is individually less complex than the given problem. Specifically, the linearity of the transport equation allows the replacement of the given problem by a structurally simpler problem plus a residual problem. By direct substitution into the transport equation, it is shown that the residual problem retains the geometry of the given problem, but has an effective source which is isolated within the spatial variation. In this manner, the doubly complex given problem may be decomposed into a spatially unperturbed problem plus a residual problem, whose virtue is an effective source in the region of primary interest. The effective source of the latter problem is shown to be a function of the solution to the former problem and the properties of the homogeneous and perturbing media. An algorithmic procedure for calculating the effective source is described. The geometrically homogeneous unperturbed problem may be solved by a variety of established techniques. The possibility of geometric complexity and the existence of an isolated effective source in the region of primary interest, however, suggests a Monte Carlo approach for the residual problem. A Monte Carlo code was written for the residual problem. It is designed to solve for the scalar flux in two-dimensional, multigroup problems. Several restrictions were imposed for convenience: (1) the extended homogeneous medium is in slab geometry; (2) the perturbing region is cylindrically symmetric about an axis perpendicular to the surface of the slab; (3) the scattering is assumed to be independent of angle; (4) only energy downscattering is assumed. This Monte Carlo code was applied to the study of two problems: (1) flux depressions due to absorbing foils; and (2) the effects of void ducts in shields. (Diss. Abstr. Int., B)

38529 NEUTRON STREAMING THROUGH DUCTS: ANALYSIS OF EXPERIMENTAL RESULTS. Song, Y. T. (Tennessee Valley Authority, Chattanooga); Huddleston, C. M.; Chilton, A. B. Nucl. Sci. Eng.; 44: 252-61(May 1971).

Previously, a Neumann series solution to the duct transport equation was developed, using an energy-group approximation within each order of scattering, with duct-wall reflections characterized by an energy- and angle-dependent differential dose albedo. As a test of the adequacy of the solution, measurements were made of neutron dose rates within concrete ducts and theoretical predictions were compared with these results. The neutron sources, the ducts used in the experiments, and the dosimetry instrumentation are described. Experimental results and background corrections are discussed. Use of the duct transport theory in numerical calculations is described. The agreement between theory and experiment is examined, and conclusions are drawn. (M.H.R.)

38530 SEMICLASSICAL ESTIMATION OF NEUTRON STOPPING POWER. Vora, R. B. (Bhabha Atomic Research Centre, Trombay, India); Neelavathi, V. N.; Turner, J. E.; Subramanian, T. S.; Prasad, M. A. Phys. Rev., B; 3: 2929-33(1 May 1971).

The semiclassical impulse approximation is used to calculate the effect on the stopping power of the charge and magnetic moment of a heavy particle. A stopping-power formula applicable when $1 < \gamma < 10$ is derived, where $\gamma = (1 - \beta^2)^{-\frac{1}{2}}$, β being the particle's speed in terms of the speed of light. Applied to neutrons, for which, apparently, no quantum-mechanical result is available, the semiclassical theory predicts for the stopping power of a medium containing NZ electrons per unit volume $-dE/ds = 1.54 \times 10^{-32} NZ(\gamma^2 - 1)(\gamma^2 + 3)$ MeV/cm. For most materials this is equivalent to $-dE/\rho ds \sim 5 \times 10^{-9}(\gamma^2 - 1)(\gamma^2 + 3)$ MeV cm^2/g. A method is suggested for observing neutron energy losses of this magnitude to atomic electrons in gases. (auth)

38531 ENERGY STRAGGLING OF ALPHA PARTICLES IN THICK ABSORBERS. Sykes, D. A.; Harris, S. J. (Univ. of Surrey, Guildford, Eng.). Nucl. Instrum. Methods; 94: No. 1, 39-43(1971).

Measurements were made of the energy straggling of ^{241}Am alpha particles through thick aluminum absorbers. A region of increasing straggling was shown to be followed by a maximum and a region of decreasing straggling towards the end of the alpha-particle range. An explanation of the reduction in energy straggling or "energy-bunching" effect was sought by reference to low-energy stopping-power data. (auth)

38532 ENERGY LOSS OF PROTONS IN THIN FILMS OF CARBON, ALUMINUM, AND SILVER. Johansen, A.; Steenstrup, S.; Wohlenberg, T. (Univ. of Copenhagen). Radiat. Eff.; 8: No. 1-2, 31-2(Mar 1971).

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The energy loss of keV protons in thin films of C, Al, and Ag is determined by a method in which the strong energy dependence of the cross section for x-ray excitation by protons, in a material, on which the films are evaporated, is used as an indicator of the proton energy. (auth)

38533 DETERMINATION OF ELECTRON ENERGY LOSSES IN ABSORBERS FROM CONTINUOUS β-SPECTRA. Fjeld, R. A. Verghese, K. (North Carolina State Univ., Raleigh). Nucl. Instrum. Methods; 93: No. 3, 573-5(1971).

The technique outlined by Melloni et al. [Nucl. Instrum. Methods 74: 101(1969)] for determining the depth of localization of beta emitters from continuous beta spectra is further investigated using ^{137}Cs. The complexity of the decay scheme limits the scope of the technique. (auth)

38534 BUILD-UP FACTOR OF γ-RAYS SCATTERED IN MULTILAYER SHIELDS. Broder, D. L.; Rubanov, S. M. Trofimov, I. N. (Physical Energetics Inst., Obninsk, USSR). Kernenergie; 13: No. 12, 380-7(Dec 1970). (In Russian).

A few-group method of calculating space and energy distribution of 0.5- to 8-MeV γ rays in multilayer shields according to Carlson' S_n method is described. Geometries of isotropic plane and point sources are considered. The results of calculations for lead/water, iron/water, iron/lead, and graphite/lead shields are given and compared with experiments published. A semi-empirical relation is proposed for calculating dose buildup factors of multilayer shields in any distance from light- and heavy-material interface. (auth)

38535 ANALYTICAL STUDY OF THE EFFECT OF ANISOTROPIC SCATTERING IN CMS ON FAST NEUTRON SPECTRUM. Yamamura, Yasunori; Sekiya, Tamotsu (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 5, 277-84(May 1971).

Using the synthetic scattering kernel presented previously a simple analytic formula for the neutron slowing-down spectrum is obtained within the order of the Greuling–Goertzel approximation under the condition that the elastic scattering is anisotropic in the center of mass system (c.m.s.). In the formula thus derived the Legendre expansion coefficient of the scattering angular distribution is included explicitly in the form of arbitrary functions of energy. Scattering and absorption cross sections are also treated as arbitrary functions of energy. Information derived directly from the formula obtained, such as resonance escape probability and the effect of finite buckling are discussed. (auth)

38536 NOTE ON THE USE OF THE TCHEBYCHEFF CRITERION FOR DETERMINATION OF PARAMETERS IN EMPIRICAL APPROXIMATIONS TO GAMMA-RAY BUILDUP FACTOR DATA. Vetter, A. F.; Chilton, A. B. (Univ. of Illinois, Urbana). Nucl. Technol.; 11: No. 2, 268-9(Jun 1971).

It is suggested that the Tchebycheff criterion for obtaining a best fit of empirical expressions to gamma-ray buildup factor data may be preferable to the least-squares method which has often been used. On this basis, parameters for the Berger formula used in connection with point-source buildup factor data were calculated for comparison with similar data previously determined on the least-square basis. Maximum percentage errors when Tchebycheff parameters are used turn out to be equal to or smaller than the corresponding maximum errors using least-square parameters. (auth)

38537 NEUTRON SHIELDING OF UNDERGROUND NUCLEAR EXPLOSIVES. Green, Joseph B. Jr.; Lessler, Richard M. (Univ. of California, Livermore). Nucl. Technol.; 11: No. 1, 357-66(Jul 1971).

The degree of success to be achieved by a Plowshare application may well depend upon the amount of radioactivity produced by the nuclear explosion. One method of reducing the soil activation is to emplace shielding material around the explosive package. A parameter study using Monte Carlo neutronics was conducted to determine the optimum moderator-to-absorber atomic ratio and identify an effective shielding material. With boron as the absorber, the most effective ratio was found to be about 30 ± 5 at. % boron, the remainder being moderator. Many materials containing boron were evaluated, and the most effective shielding material was found to be polyethylene borated at approximately 30 at. %. A sample Plowshare application was calculated for 15 cm of borated polyethylene, resulting in a reduction of soil activation by a factor of 90 over an unshielded explosive. The total radioactivity was reduced by a factor of only 80 due to tritium production in the shield itself. (auth)

38538 FAST-NEUTRON PENETRATION IN PARAFFIN AND LITHIUM HYDRIDE. Profio, A. E. (Univ. of California, Santa Barbara); Cerbone, R. J.; Huffman, D. L. Nucl. Sci. Eng.; 44: No. 3, 376-87(Jun 1971).

Time-of-flight measurements of the fast-neutron angular flux spectrum in CH_2 and LiH spheres have been made to test shielding calculations. The spheres were excited with an isotropic photofission neutron source. Measurements were compared with discrete-ordinates and Monte Carlo calculations. The major calculational difficulty was found to be the representation of the zero-degree flux in the discrete-ordinates program. (auth)

Solid-State Physics

Refer also to abstracts 38629, 38968, and 38969.

Radiation Effects

Refer also to abstracts 37410, 37597, 37679, 37705, and 37984.

38539 (CEA-R-4144) STUDY OF AGGLOMERATION OF POINT DEFECTS WITH AN ELECTRON MICROSCOPE. Bourret, Alain (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr 1971. 68p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Grenoble, Faculte des Sciences.

The nucleation and growth of agglomerated point defects produced by irradiation were studied in nickel and iron by electron microscopy. Investigations were made after neutron irradiation at 80°K, and after electron irradiation at room temperature (1 to 3 MeV). In neutron-irradiated nickel, the interstitials are clustered in Frank dislocation loops and the vacancies in small stacking-fault tetrahedra. Using a low-temperature stage on a conventional microscope, the annealing process of these defects was studied directly from 80°K to room temperature; the stage III annealing is attributed to the liberation of vacancy-type defects in aluminium and nickel. A nucleation theory based on chemical reaction rate theory is developed. Using a high-voltage electron microscope (up to 1.2 MeV), the threshold energy required to create these defects was measured in three different crystallographic directions T_{110} = 21 eV, T_{100} = 38 eV, T_{111} > 60 eV, in nickel. (auth) (France)

38540 (NRC-TT-1455) EXCITATION OF BOUND ATOMIC STATES BY A SUDDEN CHANGE OF CENTRAL FIELD RESULTING FROM β^--DECAY. Andrae, H. Juergen. Translated by Barbara E. Schneider for National Research Council of Canada, Ottawa, from Z. Phys.; 215: 279-301(1968). 29p. Dep. NTIS (U. S. Sales Only).

By the sudden change of nuclear charge during β^--decay the daughter ion is ionized or excited with probabilities of the order of some percent; other processes in the electron shell may be neglected, and therefore unperturbed excitations can be measured by detecting photons emitted from the decaying excited atomic states in delayed coincidence with β^- particles as is shown in an earlier paper for the $^{85}Kr-\beta^-$ decay. More extensive measurements of the photon emission after this decay give results in good agreement with theoretical predictions. Mostly such photons are observed, which can be emitted after a monopole excitation, for which the selection rules $\Delta J = 0$ and $\Delta l = 0$ are valid. The total excitation probability into both 5p($J = 0$) states of Rb II is found to be P(4p–5p) = 5.6 ± 1.0%. The lifetimes of these two states are measured (correspondingly) to be $\tau = 7.6 \pm 0.5$ nsec, from which the reduced matrix elements $|\langle 5p||D||5s\rangle|^2 = 18.9 \pm 3.2$ and $|\langle 5p||D||4d\rangle|^2 = 10.4 \pm 1.8$ au are calculated. (auth)

38541 (NRC-TT-1461) EXCITATION OF Rb^+ IN Kr MATRIX BY A SUDDEN CHANGE OF THE CENTRAL FIELD DUE TO β DECAY OF ^{85}Kr. Micklitz, Hans. Translated by V. Poppe and Barbara E. Schneider for National Research Council of Canada, Ottawa, from Z. Phys.; 215: 302-22(1968). 28p. Dep. NTIS (U. S. Sales Only).

After the β decay of ^{85}Kr in solid krypton, the Rb^+ ion resulting from this decay is excited in $4p^5\,5p$ ($J = 0$) states with a certain probability. The photon spectrum, due to dipole transitions from these excited states, selected with narrow-band filters and measured in coincidence with the emitted β particles, shows narrow bands ("lines") and broad bands. The "lines" are not shifted with respect to the atomic Rb^+ lines, whereas each broad band can be interpreted as a component of each "line," being shifted about 800 cm^{-1} to the blue end of the spectrum. The measured lifetime of the excited states is (7.5 ± 0.5) nsec in the "lines" and (5 ± 0.5) nsec in the bands, the measured excitation probability is $(8 \pm 1) \times 10^{-2}$ per β decay. A calculation of the magnitude of the spectral shift and the excitation probability with the LCAO approximation is made under the following assumptions: the "lines"

are due to Rb^+ ions on regular crystal sites; the shifted bands are caused by Rb^+ ions trapped at octahedral interstitial sites, after being displaced from their original regular crystal sites by the β recoil. A comparison between the experimental and calculated values confirms these assumptions. (auth)

38542 (NYO-3822-18) RADIATION DAMAGE STUDIES USING THE CORNELL 3 MeV DYNAMITRON. Final Report. Taylor, A. (Cornell Univ., Ithaca, N. Y.). 15 Jun 1970. Contract AT(30-1)3822. 7p. Dep. NTIS.

Some of the experimental difficulties in the use of the Dynamitron in studies of radiation damage in alkali metal halides are described. The growth, annealing kinetics, and bleaching of conductivity and luminescence peaks at 10 to 30°K were investigated for KBr crystals irradiated with neutrons and gamma rays. The results show that the annealing of interstitials can be studied using conductivity and luminescence. The peak at 22°K is associated with the thermal ionic current of the Br^- interstitial, while that at 28°K is complex, involving the H center. There was no difference between the neutron and gamma irradiations other than in the magnitude of the annealing peak. (D.L.C.)

38543 (RD/B/N-1915) A THEORETICAL STUDY OF THE STRUCTURE OF ATOMIC COLLISION CASCADES. PART I. METHOD OF ANALYSIS. Wheeler, G. A.; Woolley, R. L. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1971. 35p. Dep. NTIS (U. S. Sales Only).

Computer programs were written to investigate the production and structure of cascades started by ions of tens of keV in amorphous monatomic solids. From the programs the number of the defects in the cascade and their distribution in the solid can be determined, and the properties of ions transmitted by foils and sputtered from solid surfaces can be obtained. (auth) (UK)

38544 (RD/B/N-1916) A THEORETICAL STUDY OF THE STRUCTURE OF ATOMIC COLLISION CASCADES. PART II. CASCADES DERIVED FROM THE THOMAS-FERMI POTENTIAL. Wheeler, G. A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1971. 49p. Dep. NTIS (U. S. Sales Only).

An interatomic potential based upon the Thomas – Fermi model of the atom was used to calculate the amount and distribution of the damage due to collision cascades started by primary ions with tens of keV kinetic energy in carbon, iron, and uranium. The energy and angular distributions of the knocked-on atoms in the cascade also define the properties of ions that are transmitted through thin foils and sputtered from solid surfaces. (auth) (UK)

38545 CHANNELING OF ULTRARELATIVISTIC CHARGED PARTICLES IN CRYSTALS. Ferretti, B. (CERN, Geneva). pp 88-94 of Evolution of Particle Physics. /Conversi, M. (ed.). New York ; Academic Press Inc. (1970).

The problem of solving the motion of very high-energy electrons or positrons in crystals is considered for a cubic lattice. When $E_a \ll V_0$, the zero point and thermal motion affect the channeling of the positron. The effect of the atom motion is considered as produced by a small perturbation, and equations are derived for the probability of transition from ψ_a to ψ_b. Conditions for the trapping of positrons and electrons in the crystals are discussed. (D.L.C.)

38546 ELECTRON PARAMAGNETIC RESONANCE STUDY OF Al^{2+} IN BeO. DuVarney, R. C.; Garrison, A. K.; Harem, S. B. (Emory Univ., Atlanta). Phys. Status Solidi (b); 45: No. 1, 259-64(1 May 1971).

When single-crystal BeO is x-irradiated at room temperature, paramagnetic centers are formed. These centers are identified by EPR as electrons trapped at Al^{3+} impurities substitutional for beryllium ions. The g-tensor is cylindrically symmetric with values $g_{\parallel} = 2.003$ and $g_{\perp} = 2.004$ with the axis of symmetry along an Al–O bond direction. The hyperfine tensor has the principal values $A_{x'x'} = 207.6$ G, $A_{y'y'} = 175.7$ G, and $A_{z'z'} = 176.6$ G. The x′ and z′ directions lie in a plane that contains the polar or c-axis and the Al–O bond direction. The z′ axis makes an angle of 14° with the c-axis. Also, an absorption spectrum in γ-irradiated Thermalox 995, a commercial form of sintered BeO ceramic used in thermally stimulated exoelectron emission radiation dosimeters, is analyzed and shown to be the powder pattern of this aluminum impurity center. (auth)

38547 COLOUR CENTRES IN ELECTRON-IRRADIATED SODIUM BROMIDE. Calverd, A. M.; Tubbs, M. R. (Univ. of Warwick, Coventry, Eng.). Phys. Status Solidi (b); 45: No. 1, K65-8(1 May 1971).

NaBr is difficult to color, its hygroscopicity increasing the F-center concentration. The growth of the F-band was studied in NaBr single crystals irradiated with high-energy (100 to 500 keV) electrons at both liquid-nitrogen (LNT) and room temperatures (RT) in a dry atmosphere. The growth tends to saturate after doses of 3×10^{20} keV/cm^3. More F centers are produced in the RT than in the LNT irradiations. The absorption spectrum shows, besides the F band at 525 nm, a strong band at 199 nm. Coloring–bleaching experiments indicate the 199-nm band to be the α band. (D.L.C.)

38548 NEW ELECTRON PARAMAGNETIC RESONANCE IN NITROGEN-ION-IMPLANTED CdS. Sugimoto, Hiroshi (Tokyo Univ. of Agriculture and Tech.); Shiraki, Yasuhiro; Komatsubara, Kiichi F. Appl. Phys. Lett.; 18: No. 10, 461-3(15 May 1971).

The EPR of a new impurity center in nitrogen-implanted CdS was observed. The observed fine and hyperfine structures show that this center is in the triplet state (S = 1) and consists of a couple of N nuclei, which is similar to a nitrogen molecule. On the basis of the experimental data, the resonance spectrum is assigned to N_2^{-} center substituted for sulfur ion in CdS. The molecular axis of the center was found to be coincident with the crystal c axis. (auth)

38549 X-RAY INDUCED POSITRON ANNIHILATION CENTERS IN ALKALI HALIDE CRYSTALS. Brandt, W.; Coussot, G.; Paulin, R. (Institut National des Sciences et Techniques Nucleaires, Saclay, France). Phys. Lett.; 35A: No. 3, 175-6(31 May 1971).

The angular correlation of the two-gamma positron annihilation radiation is narrowed after intense x irradiation and after optical bleaching of color centers. Positron trapped in defects can account for these results. (auth)

38550 DECHANNELING OF 100-keV PROTONS IN NIOBIUM. Behrisch, R.; Scherzer, B. M. I.; Schulze, H. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett.; 35A: No. 3, 181-2(31 May 1971).

In a backscattering experiment, dechanneling probabilities for 100-keV H^+ in a ⟨111⟩ direction in Nb were measured from the increase in minimum yield with penetration depth. They are higher than the calculated values. (auth)

38551 SUSCEPTIBILITY VERSUS DENSITY CHANGE OF NEUTRON-IRRADIATED α-QUARTZ. van den Bosch, A. (SCK-CEN, Mol, Belgium). Radiat. Eff.; 8: No. 1-2, 49-50(Mar 1971).

The paramagnetism of neutron-irradiated α-quartz single crystals is given versus the relative density decrease of the specimens. There clearly exists a relation between the radiation-induced susceptibility and density change. The precise correlation, however, depends on experimental conditions, among which the irradiation temperature may be. (auth)

38552 VARIATION OF DEFECT DAMAGE WITH DEPTH IN MOLYBDENUM IRRADIATED WITH 2-MeV NITROGEN IONS. Evans, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 8: No. 1-2, 115-20(Mar 1971).

Transmission electron microscopy was used to examine the damage produced in specimens of high-purity molybdenum following irradiation with 2-MeV nitrogen ions in the Van de Graaff accelerator. A simple electropolishing technique was developed to allow the defect damage to be examined at different depths on a single specimen. Some results are presented for specimens irradiated in the range 600 to 800°C, together with theoretical predictions of the nitrogen range and the variation of displacement damage with range. The experimental results show that the defect damage to the lattice results in a structure of dislocation loops, interstitial in nature, whose size drops with distance from the bombarded surface and whose concentration increases. Nevertheless, the retained defect damage, measured by integrated loop area, agrees reasonably with the theoretical variation of displacement damage with range while the increase in loop concentration with depth coincides with the variation in ratio of nitrogen concentration to displacement damage. This latter result agrees with the hypothesis that the nucleation of damage is controlled to a large extent by the ratio of impurity atoms to displaced atoms. (auth)

38553 RADIATION DEFECTS IN SILICON OF HIGH PURITY. Konozenko, I. D.; Semenyuk, A. K.; Khivrich, V. I. (Inst. of Nuclear Research, Kiev). Radiat. Eff.; 8: No. 1-2, 121-7(Mar 1971).

Radiation defects created by γ irradiation and fast neutrons in high-purity p-Si ($\rho = 5 \times 10^3$ to 4×10^4 Ω · cm) and n-Si ($\rho = 4 \times 10^3$ to 5×10^3 Ω · cm) were investigated by measurements of Hall effect, resistivity, and minority carrier lifetime. The oxygen

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concentration in the crystals was in the range of 5×10^{14} to 5×10^{15} cm^{-3}. It is shown that stable γ defects at 300°K are divacancies and complexes of vacancies with donor or acceptor impurities. Divacancies introduced by γ irradiation are the secondary defects. They become predominant after "exhaustion" of the dopant. When divacancies become the predominant defects the Fermi level occupies its boundary position $E_v + 0.39$ eV in the gap. At low doses ($\Phi < 10^{16}$ photons/cm^2) vacancy–impurity complexes and at heavy doses ($\Phi > 10^{17}$ photons/cm^2) divacancies play the main role in the recombination process. In neutron irradiation, disordered regions are introduced, and the level at $E_v + 0.35$ eV is observed. The Fermi level in both n- and p-Si shifts to the middle of the gap. At the annealing of disordered regions in the interval 200 to 250°C the level at $E_v + 0.27$ eV appears and Fermi level occupies its boundary position at $E_v + 0.39$ eV. This indicates that divacancies become the predominant defects which can be formed as secondary defects at the destruction of the disordered regions. (auth)

38554 CRITICAL APPROACH DISTANCES AND CRITICAL ANGLES FOR CHANNELLING. Morgan, D. Vernon (Univ. of Leeds, Eng.); Van Vliet, Dirck. Radiat. Eff.; 8: No. 1-2, 51-61(Mar 1971).

The critical angles and critical approach distances, which determine the limits for the channeling of energetic ions, down open crystal directions are established by the methods of computer simulation and compared with simple analytical models. For nonvibrating rows or planes, a good agreement between the two is obtained. The complicating effects of thermal vibrations can be accounted for by empirical formulas. (auth)

38555 PROBABILITY CALCULATIONS ON THE AUTO-ANNIHILATION OF RADIATION DAMAGE IN LiF. Van Den Bosch, A. (SCK-CEN, Mol, Belgium). Radiat. Eff.; 8: No. 1-2, 63-70(Mar 1971).

Simplified models simulating the irradiation of lithium fluoride single crystals are presented. In these models the evolution of the primary defect concentration versus the number of Frenkel pairs, induced at random in the lattice, is studied from a statistical point of view. The maximum defect concentration follows as a consequence of postulated annihilation volumes in which a newly created primary recombines with one of its antidefects. The fact whether single or di-atomic interstitials are considered has only a minor effect on the maximum defect retention. (auth)

38556 NUCLEATION OF DAMAGE CENTERS DURING ION IMPLANTATION OF SILICON. Chadderton, Lewis T. (Univ. of Copenhagen. Atomic Energy Commission Research Establishment, Roskilde, Denmark). Radiat. Eff.; 8: No. 1-2, 77-86(Mar 1971).

Nucleation of damage centers in a single-crystal silicon held at room temperature and bombarded in a "random" direction with light ions is not at all times heterogeneous, as has sometimes been assumed. Homogeneous nucleation of interstitial clusters occurs at low ion fluences and this is characterized, for an extremely short period, by a linear dependence of the state of disorder on ion fluence, followed by a longer period during which disorder $\propto$ (fluence)$^{1/2}$. During these periods of "nucleation" and "primary growth," small interstitial clusters behave as unsaturable traps. For higher fluences, there is a smooth transfer to a form of damage increase which is not of displacement cascade origin. In this period of "secondary growth" the state of disorder varies linearly with ion fluence, and interstitial clusters behave as nucleation traps. It is shown how marked effects on the state of disorder due to changes in the mass of the bombarding ion, in the flux of the impinging beam, or in the temperature and impurity content of the bombarded crystal, can be simply traced to an early assistance for or a resistance to the onset of hetero- over homogeneous nucleation. (auth)

38557 ANNEALING OF DEFECT CLUSTERS IN IRRADIATED TUNGSTEN. Rau, R. C.; Moteff, J. (Univ. of Cincinnati). Radiat. Eff.; 8: No. 1-2, 99-105(Mar 1971).

Transmission electron microscopy was used to study the thermal annealing of radiation-induced defect clusters in tungsten irradiated at reactor ambient temperature, ~70°C. Annealing, consisting of the growth and eventual elimination of the clusters, is observed to occur in two stages, one at temperatures below 435°C and one at temperatures above 740°C, which are interpreted as being due to interstitial and vacancy migration, respectively. The changes in defect cluster size and density are paralleled by similar changes in the measured strength of the material, and can be quantitatively correlated with the shear stress on the basis of a model of dislocation movement through a random array of obstacles. (auth)

38558 KINETICS OF THE ANNEALING OF IRRADIATION DAMAGE AT LOW TEMPERATURES IN n-TYPE GERMANIUM. Whitehouse, J. E. (Thomson Physical Lab., Reading, Eng.). Radiat. Eff.; 8: No. 1-2, 129-33(Mar 1971).

The annealing that always occurs near 65°K following low-temperature electron irradiation of n-type germanium is governed by second-order (or higher) annealing kinetics. It follows that the experimental activation energy must vary from experiments performed on high-resistivity material where the defect concentration is low to those on low-resistivity material where the defect concentration is high. A model for the annealing of defects, which accounts for this observation and involves the diffusion of ionized interstitials, is suggested. (auth)

38559 MEASUREMENT OF THE DECHANNELING COEFFICIENT BY A STACKING FAULT IN GOLD. Mory, J. (CEN, Fontenay-aux-Roses, France). Radiat. Eff.; 8: No. 1-2, 139-41(Mar 1971). (In French).

The dechanneling coefficient (or probability) has been measured for α particles channeled between {111} planes of gold and encountering an intrinsic stacking fault. In the ⟨112⟩ direction, this coefficient is found to be 0.24, in good agreement with a theoretical determination. (auth)

38560 GAMMA RADIATION EFFECTS ON THE MECHANICAL PROPERTIES AND ON THE ELECTRIC CHARGE OF THE DISLOCATIONS IN LiF CRYSTALS. Serughetti, Jean; Schaeffer, Bernard; Dupuy, Claude H. S.; Saucier, Henri (Univ., Strasbourg). pp 251-9 of Comptes Rendus du 92e Congres National des Societes Savantes. Tome 2. Paris; Bibliotheque Nationale (1970). (In French).

From ninety-second national congress of the Learned Societies; Strasbourg, France (31 Mar 1967). See CONF-670342–(Vol. 2).

Lattice defects in ionic crystals of the NaCl type structure are recalled; they consist essentially of dislocations and color centers. The mechanical behavior of γ-irradiated lithium fluoride crystals was analyzed: the strain deformation curves and the hardening due to the radiation. Photoelastic observation of the isolated slip plane enabled the data to be simplified. Xerography and electrometric measurements established the existence of electric charges appearing during plastic deformation and were used to study them. In order to distinguish the nature of these charges, which are due to dislocations, electrometric measurements were made on crystals that had been annealed at various temperatures and then deformed at ambient temperature. An interpretation of the results in terms of the interaction between color centers and dislocations is given. (France)

38561 SELF-IRRADIATION DAMAGE IN α-PLUTONIUM. Hall, R. O. A.; Mortimer, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Low Temp. Phys.; 4: No. 4, 421-31(Apr 1971).

The change in the resistivity of high-purity α-plutonium, due to self-irradiation damage with time of holding in liquid helium, was measured. A small term, additional to the two terms previously reported, was found. A detailed analysis showed that a good fit was obtained using $(\rho - \rho_0) = 1.920[1 - \exp(-0.65 \times 10^{-3}\ t)] - 0.400[1 - \exp(-0.192 \times 10^{-2}\ t)] - 0.230[1 - \exp(-0.172 \times 10^{-3}\ t)]\ \mu\Omega m$. This analysis was also applied to earlier results on lower-purity α plutonium and to a Pu–1% Np alloy. (auth)

38562 ELECTRON PARAMAGNETIC RESONANCE STUDIES OF RADIATION-INDUCED DEFECTS IN SINGLE CRYSTALS OF LITHIUM SULFATE. Aseltine, Clifford Lee. Detroit; Wayne State Univ. (1967). 120p. University Microfilms Order No. 71-12,019.

Thesis.

Single crystals of $Li_2SO_4 \cdot H_2O$ were grown with labeled lithium and hydrogen isotopes near room temperature and irradiated by 1-MeV electrons near 77°K and thermal neutrons near room temperature. Electron paramagnetic resonance studies of the electron-irradiated samples were conducted near 77°K without warming the samples. The observed anisotropic spectra (type A) with resolved proton (or deuteron) hyperfine structure are satisfactorily described in terms of a spin Hamiltonian consisting of a Zeeman term and a proton (or deuteron) hyperfine interaction term where both the g-tensor and the hyperfine tensor are axially symmetric. The defect of axial symmetry responsible for the type A spectra is probably an OH radical with insignificant bonding to its neighbors. If Ziegler's crystallographic data are taken to be correct, the defect of axial symmetry is oriented very close to the direction of O_5-O_4. After warming the crystals used to observe the above-mentioned spectra to room temperature and again returning to 77°K, the type A spectrum from the OH radicals disappears and the two new types (B and C) of spectra are observed. The type B spectrum can be explained by an axially symmetric Hamiltonian containing a Zeeman term and an isotropic proton hyperfine interaction term. This spin Hamiltonian is assigned to a modification

of the original OH radical, forming an O_2H radical. The type C spectrum can be explained by an axially symmetric Hamiltonian containing only a Zeeman term, and is attributed to an O_2^- radical produced simultaneously with the type B center. The neutron-irradiated samples yielded spectra at 77°K that contain not only the O_2^- and O_2H radical spectra but three new spectra characteristic of the neutron-irradiated samples. One of these (type D) can be described by an axially symmetric Hamiltonian containing only the Zeeman term. This center has been assigned to an O_2^- radical. The other two spectra (types E and F) are attributed to SO_4^- radicals trapped in different environments. The isotropic line at g = 2.003 is probably not a single line as previously speculated by Wigen and Cowen but rather a compound line, containing partly the line from SO_3^- radicals. (Diss. Abstr. Int., B)

38563 EFFECTS OF GAMMA RADIATION ON GALLIUM ARSENIDE CRYSTALS AND GUNN DIODES. Brehm, Gailon Edward. Stanford, Calif.; Stanford Univ. (1970). 86p. University Microfilms Order No. 71-12,860.

Thesis.

Electrical and photoluminescence measurements were made on liquid epitaxial gallium arsenide irradiated at room temperature by 1.25-MeV ^{60}Co gamma rays. Both n- and p-type crystals with initial free carrier densities of 4×10^{15} cm^{-3} were subjected to a series of irradiations, after each of which Hall measurements were made as a function of temperature from 77 to 300°K. Photoluminescence measurements were made on irradiated and unirradiated crystals. Hall measurements on n-type crystals indicate the presence of imperfections having energy levels 0.13, 0.16, and 0.30 eV below the conduction-band minimum in irradiated GaAs. The 0.13- and 0.16-eV levels are introduced during irradiation at roughly ½ the rate at which the compensating deep acceptors are introduced. New photoluminescence peaks detected in both n- and p-type crystals indicate energy levels near the center of the band gap which may also be produced by irradiation. Hall measurements on p-type crystals indicate the presence of imperfections having energy levels 0.059 and 0.10 eV above the valence band maximum in irradiated GaAs. The Hall measurements made on these crystals before irradiation indicate the presence of impurities having energy levels in the lower 0.20 eV of the band gap; therefore, it is not possible to determine whether the 0.059 and 0.10 eV levels were produced by irradiation or merely uncovered as the free hole density was reduced by the radiation-induced deep donors. Carrier removal at room temperature is nonlinear due to the intermediate levels in both n- and p-type material. A computer simulation for various combinations of energy levels aided in understanding these effects. The carrier removal rate at 77°K was 0.012 cm^{-1} for n-type GaAs but only 0.002 for p-type crystals. Changes in Gunn diode performance caused by the gamma radiation were studied. Detailed measurements of low-field resistance were carried out together with output power and FM noise in a fixed X-band cavity as a function of gamma-ray fluence. The power output was degraded by 3 dB after a fluence of approximately 3×10^{17} photons/cm^2 and oscillations ceased at fluences of two to three times this value. The FM noise increased only slightly and can be related to the change in matching of the diodes to the cavity. These effects are explained in terms of carrier removal in that irradiation generates deep levels which trap conduction band electrons and reduce the free electron concentration. A theoretically derived power degradation curve for Gunn diodes that compares favorably with the experimental results is given. The fact that the change in room temperature carrier mobility after large irradiation doses is small indicates that mobility degradation has a negligible effect on Gunn diode performance. (Diss. Abstr. Int., B)

38564 ANNEALING OF DEFECTS WHICH ARISE IN GERMANIUM DURING BOMBARDMENT BY ARGON IONS. Kapusta, O. I.; Lebedev, S. Ya.; Omel'yanovskaya, N. M. Sov. Phys.-Solid State (Engl. Transl.); 12: No. 11, 2738-9(May 1971).

Translated from Fiz. Tverd. Tela; 12: No. 11, 3368-70(Nov 1970).

The temperature dependence (in the 200 to 800°C region) of the angular dependence of the ion–electron emission was studied for Ge(111) faces bombarded by 70-keV Ar ions. At low temperatures, the emission yield follows a $1/\cos\varphi$ law, but at higher temperatures, the entire curve is lowered, with a smoothing of the anisotropy as the temperature increases. This general decrease indicates the appearance of electron traps, probably vacancies, with temperature. The temperature dependences of the emission yields at the $\varphi_1 = 0°$ and $\varphi_2 = 20°$ minima and at the $\varphi_3 = 14°$ maximum were studied above the transition temperature, the maximum increases and the minima decrease. (D.L.C.)

38565 TRAPPING OF keV DEUTERONS IN LITHIUM. Erents, S. K.; McCracken, G. M.; Goldsmith, P. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., D (London); 4: No. 5, 672-6(May 1971).

Measurements were made of the trapping of 18-keV deuterons in solid and liquid lithium targets over the temperature range 320 to 730°K. Trapping efficiencies of 97% were observed in the liquid for doses of more than 10^{19} ions/cm^2 at temperatures up to 700°K. At higher temperatures, the dissociation of lithium deuteride prevented further trapping. In the solid lithium, the trapping efficiencies were in the range 70 to 95% but were rather irreproducible. (auth)(UK)

38566 INFLUENCE OF THE AMORPHOUS PHASE ON ION DISTRIBUTIONS AND ANNEALING BEHAVIOR OF GROUP III AND GROUP V IONS IMPLANTED INTO SILICON. Crowder, Billy L. (International Business Machines Corp., Yorktown Heights, N. Y.). J. Electrochem. Soc.; 118: No. 6, 943-52(Jun 1971).

A study was made of room-temperature implantations of group III and group V ions into amorphous Si layers prepared by the previous implantation of Si ions into crystalline Si substrates. Neutron activation combined with anodic oxidation and HF stripping techniques was used to determine the profiles of the implanted ions for ^{71}Ga and ^{121}Sb. Electrical evaluation of the implanted layers by Hall-effect and sheet-resistivity measurements in conjunction with layer removal techniques yielded profiles of the net electrically active species and the depth variation of mobility after annealing for 30 min in the temperature range 600 to 900°C. The ion species studied were ^{11}B (60 to 200 keV), ^{27}Al (200 keV), $^{69-71}Ga$ (140 and 280 keV), ^{31}P (100 to 280 keV), ^{75}As (280 keV), $^{121-123}Sb$ (120 and 260 keV), and ^{209}Bi (240 keV). The epitaxial regrowth of the amorphous phase at 600°C causes most of the implanted ions within this region to become electrically active and uncompensated for the ion species B, P, As, Sb, and Bi, even for peak ion concentrations in excess of 10^{20} cm^{-3}. For Al and Ga implants, the number of carriers was less than the number of implanted ions. The profiles obtained for these implantations into amorphous Si were compared with predictions based on the theory of Lindhard, Scharff, and Schiott. (auth)

38567 VUV EMISSION FROM SOLID KRYPTON AND XENON. Creuzburg, M. (Univ. of Rochester, N. Y.). Solid State Commun.; 9: No. 10, 665-7(15 May 1971).

The luminescence of solid noble gases in the vacuum-ultraviolet (vuv) during x irradiation was studied. The emission consists of several bands whose intensities are dependent on temperature. If these bands are assigned to electron recombination with V_K centers, as in alkali halides, reasonable Stokes' shift energies of a few eV are obtained for the relaxed excitons. (auth) (UK)

38568 OPTICAL ABSORPTION SPECTRA OF H CENTER IN CsBr. Chowdari, B. V. R.; Ikeya, M.; Itoh, N. (Nagoya Univ., Japan). Solid State Commun.; 9: No. 10, 689-91(15 May 1971). NSA

The H center in x-irradiated CsBr was studied and found to have two σ-polarized optical absorption bands at 437 and 490 nm, and one π-polarized band at 1062 nm. Oscillator strengths of these three bands were found to be in the ratio of 1: 0.2: 0.003. (auth)(UK)

38569 OPTICAL AND ELECTRON-PARAMAGNETIC RESONANCE STUDIES OF SODIUM FLUORIDE. Andrews, Ronald Allen. Detroit; Wayne State Univ. (1966). 113p. University Microfilms Order No. 71-12,018.

Thesis.

EPR studies of x-irradiated NaF crystals with and without iron impurity were made at controlled temperatures below 180°K, and optical absorption studies of the same samples were made at room temperature. The EPR absorption of x-irradiated NaF containing iron as an impurity distinguished: (i) the F-center spectrum, (ii) a spectrum isotropically centered near g = 2.002 and with a partially resolved anisotropic structure, and (iii) the Fe^+ spectrum centered near g = 4.344. By means of optical absorption studies, samples that exhibit an EPR signal due to Fe^{3+} (Type I samples) were compared with samples that show no trace of Fe^{3+} (Type II samples). The results of comparative optical absorption studies indicate that (1) during x irradiation, Type II samples color more readily than Type I samples, (2) optical bleaching with F-light is more efficient in Type I samples, and (3) the optical bleaching process exhibits very pronounced "aging" effects in Type I samples. These results are accounted for in terms of a proposed iron impurity-controlled mechanism of optical bleaching. This mechanism is based on the formation of cation–anion vacancy pairs, which are attributed to the excess cation vacancies associated with the iron impurity. The Type I samples also exhibit an unstable optical absorption band on the long-wavelength side of the F band after extended periods of optical bleaching.

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This band decays with a time constant $\tau = 7.8$ hours. Its observation is made easier by using samples that have a high optical bleaching efficiency. The observed characteristics of this unstable band suggest that it is one of the N bands of NaF, probably the N_2 band. (TSS)(Diss. Abstr. Int., B)

38570 POSITRON ANNIHILATION STUDIES IN TEFLON AND CERIUM. McNutt, John DeWight. Detroit; Wayne State Univ. (1966). 103p. University Microfilms Order No. 71-12,052.

Thesis.

The lifetimes and intensities of low-energy positrons annihilating in polytetrafluoroethylene (Teflon) and in cerium were measured. The two materials required the use of differing experimental and analysis procedures and of slightly altered electronic circuitry. Several Teflon samples of widely divergent and accurately known crystallinities were chosen for positron annihilation lifetime studies at temperatures of 300 and 77°K and at a series of temperatures between 4.2 and 1.35°K. The simultaneous determination of the effects of changing temperatures and crystallinities favors a "free-volume" theory of annihilation, in which the intermediate lifetime component is attributed to positrons annihilating with free electrons. The experimental results also suggested an expansion of the former theory to include effects arising from the existence of amorphous as well as crystalline structure in the material. A fourth, longer annihilation component was observed and is attributed to annihilations occurring in the transformed regions that result from a low-temperature transition previously observed in the crystalline structure of Teflon. Additional information concerning the nature of the transition is reported, and a possible description of the involved mechanism is advanced. The cerium investigations were motivated by the anomalous angular correlation of photons emitted by positrons annihilating in this metal, which conflicts with the 4f-to-5d electron promotion scheme postulated to explain the γ-to-α transition. The positron lifetime measurements support the contention that, at least in its effect on positron annihilations, the proposed promotion of the 4f electron to the conduction band is not sufficient to explain this low-temperature transition in cerium. (TSS) (Diss. Abstr. Int., B)

38571 ANNEALING STUDY OF GAMMA-IRRADIATED SODIUM CHLORATE USING NUCLEAR QUADRUPOLE RESONANCE. Shannon, Thomas George. Troy, N. Y.; Rensselaer Polytechnic Inst. (1971). 69p. University Microfilms Order No. 71-12,827.

Thesis.

A pure nuclear quadrupole resonance spectrometer, which has its frequency externally stabilized, is described. It has a signal-to-noise ratio of greater than 100:1 for a 35-g powder sample of sodium chlorate. It was used to observe, by means of the ^{35}Cl quadrupole resonance, the annealing of sodium chlorate that had been irradiated at −196°C with ^{60}Co gamma rays. A recovery step, in the temperature interval −50°C to −10°C, was observed that appears to be characterized by a single activation energy of 0.63 ± .06 eV and a 50% recovery of the integrated intensity of the nuclear quadrupole resonance absorption. It is suggested that this recovery is caused by the freeing of trapped oxygen atoms, produced by the irradiation, which then diffuse through the crystal to combine with other defects to reduce the net strain in the crystal. (Diss. Abstr. Int., B)

38572 ELECTRON PARAMAGNETIC RESONANCE ABSORPTION STUDIES OF $(Al_2O_3)_{1-x}(Cr_2O_3)_x$ WITH CONTROLLED NEUTRON TREATMENTS. Wenzel, Richard Frederick. Detroit; (Wayne State Univ. (1966). 77p. University Microfilms Order No. 71-12,075.

Thesis.

The linewidth variation of the electron paramagnetic resonance (EPR) absorption of Cr^{3+} ions in $(Al_2O_3)_{1-x}(Cr_2O_3)_x$ with $x = 0.001$ to 0.01% was investigated. These investigations were carried out with unirradiated and fast-neutron-irradiated samples. The observed linewidth of the unirradiated samples was found to vary substantially, depending on the θ coordinate of the magnetic field. The observed angular variation was compared with the angular variation predicted by three defect models: a mosaic model, a strain model, and a hybrid model. This comparison reveals that the predicted angular variations for all three models are in qualitative agreement with the observed angular variation. Quantitatively, however, none of the models predicts the variation for all angles of θ. Some discussions of the discrepancies are presented. The observed linewidth of the fast neutron-irradiated samples (10^{18} to 10^{19} nvt) was found to be larger than that of the unirradiated samples, and to depend on both the θ and Φ coordinates of the magnetic field. Small shifts in the center of resonance of the EPR lines were also observed. The observed angular variation of the linewidth due to the irradiation was compared with the variation predicted by two defect models, a strain-source model and a charge-source model. The strain-source model was found to satisfactorily predict the observed angular variation, while the variation predicted by the charge-source model was a less satisfactory fit to the experimental data. The strain-source model was also found to be consistent with the observed shifts in resonant magnetic field. It is thus likely that the linewidth variation of the irradiated samples is caused by radiation-induced strain sources. (Diss. Abstr. Int., B)

38573 NUCLEAR SPIN–LATTICE RELAXATION AND DYNAMIC POLARIZATION RATES IN IRRADIATED LiF. Valentine, Kenneth Morrison. Austin, Tex.; Univ. of Texas (1970). 94p. University Microfilms Order No. 71-11,618.

Thesis.

The dependence of the spin–lattice relaxation time (T_1) of fluorine nuclei containing gamma radiation-produced F centers, as a function of the optically determined relative F-center concentration (N_m) and temperature, was investigated at 300, 77, and 4.2 to 1.7°K. Measurements were also made of the dynamic polarization rate of the fluorine nuclei at 1.7°K as a function of the microwave power used to saturate the forbidden electron spin transitions of the F centers. At 300°K, it was found that $T_1 \propto (N_m)^{-1}$, but calculation of T_1 from theory indicates that the optically determined values of N_m are from one to two orders of magnitude too large to be compatible with the observed T_1 values. This is taken to indicate that the F centers were distributed in isolated clusters and that the number of clusters per unit volume was proportional to N_m. At 4.2°K, it was found that $T_1 \propto (N_m)^{-1.8}$, which suggests that temperature-independent electron spin–spin relaxation, characterized by a correlation time $\tau_s \propto (N_m)^{-1}$, was the dominant factor in controlling the nuclear spin–lattice relaxation at liquid helium temperatures. For the temperature range 4.2 to 1.7°K, it was found that $T_1 \propto T^{-\alpha}$ ($\alpha \sim 0.52$ to 0.58) indicating that the nuclear spin–lattice relaxation process is intermediate to the slow and rapid spin-diffusion cases. The assumption that τ_s is temperature-independent is shown to give good theoretical agreement with the data. An estimate of τ_s is obtained in the analysis of the dynamic polarization data. (Diss. Abstr. Int., B)

38574 STUDIES ON NONMETALS DURING IRRADIATION: THE GROWTH OF F CENTERS IN KCl AT 85°K. Lengweiler, K.; Mattern, P. L.; Levy, P. W. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 26: No. 22, 1375-8(31 May 1971).

Curves of KCl F center versus dose, obtained by making absorption measurements during irradiation with ^{60}Co γ rays at 85°K, are accurately described by $\alpha(t) = A_1[1 - \exp(a_1 t)] + \alpha_L t$. After irradiation, the coloring decays less than 1% in 8×10^4 sec. A_1 is independent of, and a_1 and α_L are proportional to, the dose rate. These observations are in accord with a particularly simple phenomenological theory of radiation-induced color-center formation. (auth)

38575 INDUCED RADIATION OF $Y_3Al_5O_{12}$: $(Nd)^{3+}$ EXCITED BY AN ELECTRON BEAM. Voron'ko, Yu. K.; Nolle, E. L.; Osiko, V. V.; Timoshechkin, M. I. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 13: No. 3, 86-8(5 Feb 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 3, 125-8(5 Feb 1971).

Stimulated radiation excited by 90-keV electron pulses was studied in $Y_3Al_5O_{12}$: 0.3 wt % Nd^{3+} garnet single crystals by measuring the energy yield and the quantum yield over the spectrum. Emission from resonators with silvered ends was investigated, and the results indicate stimulated radiation (laser). The threshold of the stimulated emission was determined to lie at electron-current densities $<10^{-2}$ A/cm^2. It is concluded that electronic excitation makes it possible to construct $Y_3Al_5O_{12}$: Nd^{3+} lasers not only in the infrared region, but also in the visible region. (D.L.C.)

Physical Properties

Refer also to abstracts 37954, 38020, and 39315.

38576 (JINR–E2-5766) POSSIBILITIES OF OBSERVATION OF MAGNETIC SURFACE MODES USING INELASTIC NEUTRON SCATTERING. Heber, G.; Elk, K. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 10p. Dep. NTIS (U. S. Sales Only).

Possibilities are discussed of observing surface magnons. From consideration of the cross section and transition probabilities of the neutron spin, it is concluded that the inelastic neutron scattering with special experimental conditions gives

such possibilities. Thin layers, total reflection, spin depolarization, and influence of surface anisotropy are considered. (auth)

38577 (RPI-1044-23) ANISOTROPY IN ELECTROMIGRATION. Hungtington, H. B.; Alexander, W. B.; Feit, M. D.; Routbort, J. L. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Physics and Astronomy). Jul 1970. Contract AT(30-1)-1044. 18p. (CONF-700639-2). Dep. NTIS.

From International conference on atomic transport in solids and liquids; Marstrand, Sweden (16 Jun 1970).

Three separate but closely related investigations dealing with the anisotropy of electromigration as observed in noncubic single crystals of metals are reported. A simplified application was made to zinc and the need for a more thorough treatment is demonstrated. Results for electromigration in cadmium are briefly summarized. Theory for electromigration in nearly free electron metals is also presented briefly. (W.D.M.)

38578 RADIO-FREQUENCY SIZE EFFECT AND THE FERMI SURFACE OF MOLYBDENUM. Cleveland, J. R.; Stanford, J. L. (Iowa State Univ., Ames). Phys. Rev., B; 4: No. 2, 311-19(15 Jul 1971).

Fermi-surface dimensions for the (110) plane for molybdenum are determined from caliper dimensions obtained through radio-frequency size-effect measurements. These measurements were taken over a frequency range of 6.5 to 26 MHz on high-purity molybdenum approximately 0.13 mm in thickness. Studies of the frequency dependence of the extrema in the resonance line shape were used to determine the magnetic field values for resonances along major crystallographic directions. The Fermi-surface dimensions are compared with recent theoretical and experimental work on molybdenum. (auth)

38579 CONDUCTION BAND OF IVa AND Va SUBGROUP TRANSITION METAL MONOCARBIDES. II. Borukhovich, A. S.; Geld, P. V.; Tskhai, V. A.; Dubrovskaya, L. B.; Matveenko, I. I. (Inst. of Chemistry, Sverdlovsk, USSR). Phys. Status Solidi (b); 45: No. 1, 179-87(1 May 1971).

Results are presented of a study of the Hall effect (in the low-temperature range 20 to 300°K) and of the thermopower of the monocarbides VC_x, NbC_x, and TaC_x within the limits of their homogeneity regions. Basing on the experimental results obtained and on earlier data on magnetic susceptibility and electric resistivity, the electronic spectrum of nonstoichiometric monocarbides is discussed on the basis of a band model (Phys. Status Solidi 42: 85(1970)). (auth)

38580 ORIGIN OF THE SPONTANEOUS POLARIZATION AND THE ISOTOPE EFFECTS IN FERROELECTRIC KH_2PO_4 CRYSTALS. Bersuker, I. B.; Vekhter, B. G.; Muzalevskii, A. A. (Inst. of Chemistry, Kishinev). Phys. Status Solidi (b); 45: No. 1, K25-7(1 May 1971).

The experimental data indicate an interaction between the H system and other possible dipole structures of the KH_2PO_4 crystal. It is shown that the spontaneous polarization and the ferroelectric phase transition can be explained straightforwardly from the developing interband interaction and dipole instability in the microtheory of ferroelectricity. Equations are derived for the interaction of tetrahedral systems of PO_4 groups and H bonds. The phase transition temperature is shown to depend on both the tunneling frequencies of PO_4 and H, leading to the two isotope effects. The predictions are in good qualitative agreement with experiment. (D.L.C.)

38581 TIME-DEPENDENT MAGNETIZATION IN DyCoNi. Taylor, K. N. R. (Univ. of Durham, Eng.). Phys. Lett.; 35A: No. 3, 153-4(31 May 1971).

The magnetization at 4.2°K of DyCoNi was observed to increase with time in a constant applied field for periods of many minutes. The time constant of this rise depends on the rate at which the applied field is increased. In pulsed fields an anomalous family of hysteresis loops is observed, which is interpreted in terms of this variable time constant. (auth)

38582 PRESSURE DEPENDENCE OF THE FERMI SURFACE OF W. Schirber, J. E. (Sandia Labs., Albuquerque, N. Mex.). Phys. Lett.; 35A: No. 3, 194-5(31 May 1971).

Pressure derivatives of cross sections of the Fermi surface of W were obtained using the fluid-helium phase-shift technique. Large departures from the free-electron scaling prediction were observed for several of the cross sections. (auth)

38583 X-RAY DIFFRACTION USING ^{55}Fe SOURCES. Preuss, L. E.; Toothacker, W. S. (Edsel B. Ford Inst. for Medical Research, Detroit). Nature (London) Phys. Sci.; 231: 19-20(3 May 1971).

The criticisms of Lobov, et al. (Nature, 222: 767(1969)) on the studies of the present authors (Nature, 216: 255(1967)) on x-ray diffraction using an ^{55}Fe source and modified Debye-Scherrer geometry are discussed. These relate mainly to contamination of the source with ^{59}Fe and ^{54}Mn and the mode of production of the ^{55}Fe (reactor or accelerator), and the effect of internal bremsstrahlung. Lobov et al. also state that it is better to use focusing radial geometry because it is more efficient than Debye-Scherrer geometry, but it is stated that a Debye camera allows a decrease in entrance slit and improved quality. Some comparisons are also made between the work of the present authors and that of Lobov et al. on powder-diffraction patterns of LiF. (UK)

38584 THEORY OF SPIN WAVES IN THE HEAVY RARE EARTH METALS. Goodings, D. A.; Southern, B. W. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 49: No. 11, 1137-61(1 May 1971).

A theory of spin waves for the spin structures found in the rare earth metals of hcp crystal structure is described. The theory is developed for the conical spiral spin structure which contains the planar spiral, the nonplanar ferromagnet, and the planar ferromagnet as special cases. Included in the Hamiltonian are isotropic and anisotropic exchange interactions, single-ion crystal field terms, and magneto-elastic terms, both of the single-ion type (linear in the strains and up to fourth order in the spin operators) and of the two-ion type (linear in the strains and second order in the spin operators). The magneto-elastic effects are discussed in considerable detail, both in the "frozen-lattice approximation" and in the opposite limit in which the strains closely follow the motion of the (uniformly) precessing spins. Equations of motion for the spin operators are linearized with the help of the random phase approximation which makes it possible to express some spin-wave interaction effects in terms of powers of the reduced magnetization. Expressions for the spin-wave energies are given for the planar spiral, the nonplanar ferromagnet, and the planar ferromagnet, taking advantage of the simplifying features in each case. (auth) (Canada)

38585 INTERNAL ELECTRIC AND MAGNETIC EFFECTS ON THE DIFFERENTIAL ANGULAR CORRELATION. Bibiloni, A. G.; Lopez-Garcia, A. (Univ. Nacional, La Plata). Nucl. Instrum. Methods; 92: 253-6(1971).

The influence of an internal magnetic field and an axially symmetric electric field gradient on differential angular correlations has been investigated previously. It is the purpose of this paper to extend such calculations to: (a) the axially symmetric electric field axis not parallel to the magnetic axis; (b) a nonaxially symmetric electric field gradient. The numerical results for the spin value I = 1 show that the differential correlation can measure the asymmetric parameters. (auth)

38586 MAGNETIC FORM FACTOR AND MAGNETIZATION DENSITIES BY MEANS OF POLARIZED NEUTRONS. Paoletti, A. (Univ., Aquila, Italy. CNR, Rome). Riv. Nuovo Cim.; 2: No. 4, 451-97(Oct-Dec 1970).

A review is presented of the use of the polarized-neutron technique to study magnetic form factors. After a consideration of the methods for deriving the magnetization densities and the errors in the measurements, studies are reviewed for the following classes of materials: 3d metals (Co, Ni, and Fe), Tb, ordered and disordered alloys ($CoPt_3$ and $MnPt_3$), and compounds (NiO, MnF_2, $MnCO_3$, $CuCl_2$, and $CuSO_4$). 28 references. (D.L.C.)

38587 INFRARED AND RAMAN SPECTRA OF ZIRCONIA POLYMORPHS. Phillippi, C. M.; Mazdiyasni, K. S. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). J. Amer. Ceram. Soc.; 54: No. 5, 254-8(May 1971).

The infrared and Raman frequencies of monoclinic zirconia and of stabilized and metastable tetragonal and cubic zirconias were established. Infrared spectra were examined by the powder transmission (CsI pellet) and surface reflection techniques. The effects of heating, grinding, and adding stabilizing oxides on the ir spectra were determined. The spectra develop additional bands as the crystal symmetry is lowered, and certain of these bands are highly sensitive to strain-induced distortions of the crystal lattice. Practical applications of ir and Raman spectroscopy to zirconia technology are discussed. (auth)

38588 USE OF THE RENUCCI METHOD TO TEST THE VALIDITY OF THE MATTHIESSEN RULE: APPLICATION TO NIOBIUM. Abraham, Jean-Marie; Deviot, Bernard (Ecole Nationale Superieure de Metallurgie, Nancy. Ecole Nationale Superieure de l'Industrie des Mines, Nancy). Compt. Rend., Ser. B; 272: No. 17, 1007-9(26 Apr 1971). (In French).

The method proposed by Renucci to test the validity of the

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Matthiessen rule is studied with the Kohler model. A small deviation from the rule was revealed for niobium. (France)

38589 ANOMALY OF THE MAGNETIC SUSCEPTIBILITY OF DYSPROSIUM NEAR THE NEEL POINT. Boyarskii, L. A.; Starikov, M. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 12: No. 11, 2569-72(May 1971).

Translated from Fiz. Tverd. Tela; 12: No. 11, 3179-83(Nov 1970).

The magnetic susceptibility of polycrystalline dysprosium was measured with a vibrating-sample magnetometer in a field of 30 Oe in the range 160-230°K. Above 190°K, the susceptibility obeyed the Curie–Weiss law with the parameters $\Theta = (156 \pm 0.2)$°K and $\mu_{eff} = 10.57 \pm 0.05\ \mu_B$. It was found that near the Néel point ($T_N = 178.65 \pm 0.05$°K) there was a range of temperatures $0.1 < \tau < 0.001$, where $\tau = |T - T_N|/T_N$, in which the derivative of the susceptibility $d(\chi T)/dT$ had a nearly logarithmic singularity. The exponent α of the power function which approximated the logarithm was 0.025 ± 0.025. The positive sign of this exponent was due to the influence of impurities. The results were compared with the measured values of the electrical resistivity and the specific heat of the same dysprosium sample. (auth)

38590 THEORY OF POSITRON ANNIHILATION AT F CENTERS. Berezin, A. A. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 12: No. 11, 2684-5(May 1971).

Translated from Fiz. Tverd. Tela; 12: No. 11, 3315-17(Nov 1970).

Herlach and Heinrich (Phys. Letters, 31A: 47(1970)) studied experimentally the positron annihilation by the optical electrons of F centers in KCl crystals. Comparison with calculations shows that the semi-empirical F-center wave function gives results closer to experiment than the variational wave function. The possibility of a bound state of a positron with an F center is discussed. (D.L.C.)

38591 DIFFUSION OF SiO MOLECULES ALONG A TUNGSTEN SURFACE IN STRONG ELECTRIC FIELDS. Vladimirov, G. G.; Shakirova, S. A.; Sokol'skaya, I. L. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 12: No. 11, 2748-9(May 1971).

Translated from Fiz. Tverd. Tela; 12: No. 11, 3378-80(Nov 1970).

The surface-diffusion activation energy in a strong electric field was measured for SiO, an adsorbate which does not change the work function of W. The field-emission current was measured as a function of SiO deposition time. The activation energy was determined for various adsorbate concentrations (0.4 to 0.7 monolayers) as a function of the magnitude and sign of the field in the (121) → (001) direction. The dependence on the field intensity is linear, the slope corresponds to a negative dipole moment, and the dipole moment decreases with increased covering of the surface. There is no correlation between the change in the work function and the effective dipole moment. (D.L.C.)

38592 OBSERVATION OF PLASMA RESONANCE AT 790 A IN REFLECTANCE FROM THIN ZIRCONIUM FILMS. Rudisill, John Earl. Los Angeles; Univ. of Southern California (1970). 74p. University Microfilms Order No. 71-12,415.

Thesis.

The optical plasma resonance absorption of thin films of zirconium was investigated in the spectral region from 500 to 1000 Å. Radiation from a low-pressure argon spark discharge source was dispersed by an ultrahigh-vacuum Seya monochromator into an ultrahigh-vacuum reflectometer via an optical path which avoided all material windows. The radiation was polarized by a triple-reflection polarizer and reflected from zirconium films freshly deposited on glass substrates. The deposition was done by evaporation from an electron gun source at pressures of 1×10^{-8} torr, and the resulting film thicknesses were measured with a Tolansky interferometer. Reflectance measurements were taken with both p-polarized light (electric vector parallel to the plane of incidence) and s-polarized light (electric vector perpendicular to the plane of incidence). The observed plasma resonance at 790 Å (15.7 eV) in the reflection spectrum was compared with published characteristic electron loss data and with the calculated plasma resonance energy for a noninteracting free-electron gas. The relative half-width of the resonance peak was also compared to several of the most thoroughly investigated materials in optical plasma resonance studies. (Diss. Abstr. Int., B)

38593 SPECIFIC ELECTRICAL RESISTIVITY OF YTTRIUM. Petrov, V. A.; Chekhovskoi, V. Ya. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 5, 1039-41(Sep-Oct 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 5, 1106-8(Sep-Oct 1970).

Measurements were carried out at 298 to 1700°K on three Y samples in argon or vacuum. The results are compared with those of other investigators; the discrepancies are probably due to differences in the impurity contents. (D.L.C.)

Moessbauer Effects and NMR

Refer also to abstracts 37631, 37634, and 37685.

38594 NUCLEAR SPIN RELAXATION RATES BY NMR ON ORIENTED NUCLEI: ^{60}CoCo. Barclay, J. A. (Univ. of California, Berkeley); Gabriel, H. J. Low Temp. Phys.; 4: No. 4, 459-68(Apr 1971).

A general multipole relaxation theory (Gabriel, Phys. Rev., 181: 506(1969)) was applied to the interpretation of the nuclear spin-lattice relaxation times of ^{60}Co in Co at nuclear orientation temperatures. In order to do this, a numerical method for calculating the relaxation factors for high spins at low temperatures was developed. The initial conditions and experimental details are discussed. (auth)

38595 CONCENTRATION DEPENDENCE OF ELECTRIC FIELD GRADIENT IN THE NbHf SYSTEM. Klyucharev, V. A.; Bozhko, V. P. (Physical-Tech. Inst., Kiev). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1742-7(May 1971). (In Russian).

The dependence of quadrupole precession frequency ω_0 in NbHf alloys on hafnium concentration is measured by the perturbed angular correlation technique. In the concentration range investigated (0.035 to 50 at. %), the alloys crystallize into a body-centered-cubic lattice. The quadrupole interaction parameters are derived from the differential angular correlation function for the 133–482-keV $\gamma\gamma$ cascade in ^{181}Ta. The variation of ω_0 with hafnium concentration c is satisfactorily described by the empirical formula $\omega_0 = 290[1 - \exp(-11\ c)]$ MHz. For all samples studied, the frequency spread $\delta = \Delta\omega_0/\omega_0 = 0.35$. A contribution of quadrupole interaction of frequency ω_0' is observed in alloys containing 10% or less of Hf. The frequency ω_0' increases with decrease of hafnium content. The anomalous behavior of ω_0' may be due to violation of statistical distribution of impurities in niobium and to formation of impurity atom associations. (auth)

38596 EFFECT OF CHEMICAL BOND ON INTERNAL CONVERSION IN THE VALENCE SHELL OF THE 35.48 keV γ TRANSITION IN ^{125}Te AND AN ESTIMATE OF THE NUCLEAR RADIUS CHANGE. Makaryunas, K. V.; Kalinauskas, R. A.; Davidonis, R. I. (Inst. of Physics and Mathematics, Vilnyus, USSR). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1569-71(May 1971). (In Russian).

It is found that the chemical bond in ZnTe affects the internal conversion in the O shell of the 35.48-keV transition γ rays in ^{125}Te nuclei. A comparison of the results obtained with available data on the Moessbauer isomer shift yields the value $\Delta R/R = (1.3 \pm 0.9) \times 10^{-4}$. (auth)

38597 MOESSBAUER INVESTIGATION OF THE VIBRATIONS OF TIN ATOMS IN V–Sn AND Ti–Sn ALLOYS. Balkashin, O. P.; Chekin, V. V.; Tarasov, N. D. (Physical-Technical Inst. of Low Temperatures, Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 12: No. 11, 2554-8(May 1971).

Translated from Fiz. Tverd. Tela; 12: No. 11, 3160-5(Nov 1970).

Measurements were made of the probability of resonance absorption by ^{119}Sn nuclei in V–Sn and Ti–Sn solid solutions. The temperature dependences of the probability, obtained in the range 4.2 to 575°K for alloys containing 1 at. % Sn, were found to be described satisfactorily by the one-parameter Debye approximation. The dependence of the probability of resonance absorption on the composition was investigated at two temperatures: 4.2 and 295°K. The applicability of the harmonic approximation to concentrated alloys is discussed. (auth)

38598 NONMONOTONIC CONCENTRATION DEPENDENCE OF THE FORCE CONSTANT IN THE α PHASE OF In–Sn. Balkashin, O. P.; Chekin, V. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Sov. Phys.-Solid State (Engl. Transl); 12: No. 11, 2707-8(May 1971).

Translated from Fiz. Tverd. Tela; 12: No. 11, 3339-40(Nov 1970).

The probability of Moessbauer resonant absorption was measured at 4.2°K in In–Sn alloys containing 0.5 to 15 mole % Sn, using a $^{119}SnO_2$ source. A plot of the probability vs concentration shows a nonmonotonic dependence, with a distinct minimum at 5 mole % Sn and a diffuse maximum at 8 to 10 mole % Sn. The plot of the Debye temperature of the impurity shows a similar dependence. The nonmonotonic dependences are due to changes

in the impurity–matrix force constants which may be caused by a rearrangement of the band structure. (D.L.C.)

Theoretical Physics

Refer also to abstracts 38772, 38788, 38969, 39112, and 39337.

38599 VON NEUMANN'S THEOREM AND HIDDEN-VARIABLE MODELS. Capasso, V.; Fortunato, D.; Selleri, F. (Univ., Bari, Italy). Riv. Nuovo Cim.; 2: 149-99(Apr-Jun 1970).

The theorems that have been presented on hidden variables are reviewed and discussed critically, starting with von Neumann's theorem. Some examples of hidden-variable models most suitable for experimental verification are discussed. (M.H.R.)

38600 QUANTUM JUMPS AS A CONTINUOUS PROCESS IN A WAVE-MECHANICAL, DELAYED, ACTION-AT-A-DISTANCE THEORY. Leiter, D. (Univ. of Windsor, Ont.). Nuovo Cim.; 2A: 679-94(1 Apr 1971).

The detailed solutions to a one-dimensional theory of charged simple harmonic oscillators, interacting through a scalar delayed action-at-a-distance type of coupling are studied. The resulting formalism represents a nonlinear wave-mechanical theory for atomic processes in the microcosm. The inherent limit cycle solutions of the theory are in one-to-one correspondence with the conventional quantum-mechanical levels of a simple harmonic oscillator. However, the nonlinear limit cycle transition solutions describe quantum jumps in the theory, in a continuous and temporal fashion in space-time. The similarities and differences between this type of theory and that of quantum mechanics are discussed with regard to the predictions about the lifetimes of excited atomic oscillator states. (auth)

38601 NOTE ON THE PHASE OF PHOTONS. von Baltz, R. (Univ., Karlsruhe, Ger.). Phys. Lett.; 33A: 28-9(21 Sep 1970).

The probability distribution is calculated for phase measurements on the radiation field that consists of one single mode for the number states and the coherent states. The new phase operator constructed by Varga and Aks is used. (auth)

38602 THEORETICAL STUDY OF THE SEMI-CLASSICAL INTERACTION BETWEEN AN ELECTROMAGNETIC FIELD AND A THREE-LEVEL QUANTUM SYSTEM. Oliver, G. (Faculte des Sciences Orsay, France). Physica; 51: 197-214(29 Jan 1971).

A method is developed for calculating in the semiclassical approximation the wavefunction of a multi-level quantum system interacting with a monochromatic electromagnetic field which induces transitions between the fundamental level and a cluster of excited levels. The "fast" exponentials are neglected. This method is applied to a three-level system and three cases are studied: in the case of two equally weak interactions, the behavior of the photon echo in a three-level system is explained; in the case of a weak resonant interaction and a strong nonresonant interaction, a shift of the resonance frequency due to the strongly coupled state is found; and in the case of a strong resonant interaction and a weak nonresonant interaction, one finds that it is possible to populate strongly the weakly coupled excited state. (auth)

38603 CAN QUANTUM STATES BE CONSIDERED AS ENSEMBLES OF DISPERSION-FREE STATES. II. Ochs, W. (Univ., Munich). Z. Naturforsch.; 26a: 204-14(Feb 1971). (In German).

A model representing quantum states by ensembles of dispersion-free states was constructed in Part I. Further properties of this model are studied, and their logical relations are analyzed. It is also shown that the main results do not depend on the assumption that each self-adjoint operator corresponds to an observable. (auth)

38604 QUANTUM THEORY OF OPTICAL FREQUENCY MODULATION OF AN ELECTRON BEAM. Varshalovich, D. A.; D'yakonov, M. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 60: 90-101(Jan 1971). (In Russian).

A quantum theory of modulation is developed for an electron beam traversing a film along which an electromagnetic wave is propagating. It is shown that quantum effects dominate in the optical frequency range. The main result of the theory is that it yields a spatial dependence of the modulation that is essentially different from that in classical theory. Regions of strong modulation periodically appear at large distances from the film where classical mechanics predict the absence of modulation. The radiation produced in the interaction between a modulated electron beam and a metallic screen is considered, and it is shown to be pronouncedly anisotropic. (auth)

38605 CRITICAL REVIEW OF THERMODYNAMICS. Proceedings of an International Symposium held at Pittsburgh, Pennsylvania, April 7–8, 1969. Stuart, Edward B.; Gal-Or, Benjamin; Brainard, Alan J. (eds.). University of Pittsburgh School of Engineering Publication Series, Number 3. Baltimore; Mono Book Corporation (1970). 540p. $25.00. (CONF-690453).

The conference emphasized that is is necessary to review, criticize, attack, and defend basic ideas concerning the nature of thermodynamics periodically. The search for better thermodynamic foundations is not merely a necessity, but is due to the failure of classical, statistical, and relativistic thermodynamics to solve and eliminate the existing problems, inconsistencies, and paradoxes inherent in present-day thermodynamic theories. The arrow of time, the concept of entropy in a relativistic system, and the basic concept of temperature are among the topics considered. (J.C.W.)

38606 TRANSFORMATION TO ROTATING COORDINATES: REPLY TO ATWATER. REPLY TO MARSH AND NOONAN. Marsh, G. E. (Univ. of Chicago); Noonan, Thomas W.; Atwater, H. A. Nature (London) Phys. Sci.; 230: 197-8(26 Apr 1971).

Reference is made to Atwater (Nature, 228: 272(1970)) who, in his treatment of the transformation to rotating coordinates arbitrarily applied a simple Lorentz transformation to the periphery of a rotating disk having a symmetrical pattern and obtained, by using a constant radius, an asymmetrical pattern, and also concluded that the special theory of relativity may not be applied to the problem of the rotating disk. Marsh gives reasons why he considers this conclusion may be unwarranted. Noonan also replies to Atwater by saying that the latter's treatment of the rotating disk in special relativity is open to question because of elasticity and dynamical considerations. Noonan also stresses the fundamental that special relativity is perfectly applicable to all problems that do not involve gravitation. A reply from Atwater is included. (UK)

38607 MOMENT COMPARISON OF TWO DECOUPLING PROCEDURES FOR GREEN-FUNCTION EQUATIONS. Frank, Barry (Sir George Williams Univ., Montreal). Can. J. Phys.; 49: 776-9(15 Mar 1971).

A recently developed moment theorem and an approximation scheme of Pryce and Stevens were used to compare 2nd-RPA and Tomita–Tanaka type decoupling procedures for Green function equations. The comparison was accomplished from the point of view of the moments of the paramagnetic resonance line shapes that the decouplings generate. An Ising system in an external magnetic field was taken as the model system. It was found that use of the more complicated 2nd RPA is justified only if accuracy to $O(1/z^2)$ is desired. (auth) (Canada)

38608 MASTER EQUATION FOR THE P REPRESENTATION. Crosignani, B. (California Inst. of Tech., Pasadena); Solimeno, S.; Di Porto, Paolo. Phys. Rev. Lett.; 26: 1130-2(3 May 1971).

A master equation for the P representation in the Schrödinger picture is derived for a general class of Hamiltonians. (auth)

38609 SCATTERING BY RANDOMLY FLUCTUATING BOUNDED REGIONS. Kupiec, Israel. Brooklyn; Polytechnic Inst. of Brooklyn (1970). 120p. University Microfilms Order No. 70-26,074.

Thesis.

A consistent treatment of randomly fluctuating bounded regions with sharp interfaces is presented. The analysis is carried out for an approximate set of equations referred to in the literature as the "bilocal approximation," but in contrast to previous studies, boundary conditions at interfaces are imposed consistently on the coherent (mean) and incoherent (fluctuating) fields. It is shown in general that boundary effects cannot be ignored and that for propagation of the mean wave, it is incorrect to replace the bounded medium merely by the effective wavenumber known to be descriptive of coherent wave effects in an unbounded medium. (TSS) (Diss. Abstr. Int., B)

38610 LIMITS OF THE ADIABATIC APPROXIMATION. Spavieri, Gianfranco (Univ. of California, Santa Cruz). Amer. J. Phys.; 39: 599-605(Jun 1971).

The exact solution for the motion of a particle with charge e and mass m, moving in a spatially uniform magnetic field with the time variation $B(t) = B_0 e^{-t/\tau}$, is given in the nonrelativistic case. The trajectory of the particle was plotted for various values of τ and limits are given for the validity of the "adiabatic approximation" and the "sudden approximation." (auth)

38611 DERIVATION OF A HAMILTONIAN FOR A CHARGED PARTICLE WITHOUT RECOURSE TO ELECTROMAGNETIC POTENTIALS. Hansen, Aage E. (Univ. of Copenhagen). Amer. J. Phys.; 39: 653-6(Jun 1971).

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The Hamiltonian for a charged particle in an electromagnetic field is usually presented in terms of the electromagnetic potentials A and ϕ. However, for discussions of a large number of atomic and molecular properties, it is more convenient to have available a Hamiltonian expressed directly in terms of the more familiar electric field E and magnetic induction B. It is shown that one can construct a generalized velocity-dependent potential function of E and B, which yields the correct expression for the Lorentz force (truncated after the electric–quadrupole, magnetic–dipole terms). From this generalized potential the corresponding classical Lagrangian and Hamiltonian are obtained directly in terms of E and B. The transition to a quantum mechanical [E,B]-dependent Hamiltonian operator is considered, and a variety of static, as well as time-dependent atomic and molecular properties are listed, which can be discussed in a unified way using this Hamiltonian as a starting point. (auth)

38612 QUANTUM THEORY OF AN ELECTRON IN A UNIFORM TIME-DEPENDENT FIELD. Harris, E. G. (Univ. of Tennessee, Knoxville). Amer. J. Phys.: 39: 683-4(Jun 1971).

In the classical mechanics, the problem of an electron in an electric field that is uniform in space but an arbitrary function of time is solvable. A simple solution to the problem involving the corresponding quantum-mechanical problem is presented. The solution given is an eigenfunction of the velocity operator with the time-dependent eigenvalue that is the velocity given by the classical solution. In the given solution, the position of the electron is completely uncertain. (J.C.W.)

38613 CLASSICAL THEORY OF ELECTRIC AND MAGNETIC FIELDS. Good, Roland H. Jr.; Nelson, Terence J. New York; Academic Press, Inc. (1971). 648p. $14.50.

The classical theory of electricity and magnetism is described, and the fundamental experiments and ideas are reviewed, starting with static phenomena and ending with the electromagnetic interpretation of light. Essential mathematical tools, Maxwell's equation, Gauss's and Stokes's theorems, the Cartesian vector, and tensor analysis are clarified. Maxwell's theory is developed from statics to electromagnetic waves in three-vector notation in terms of the electric and magnetic fields and is emphasized in radiation and guided-wave studies. The special theory of relativity is covered and provides a deeper understanding of Maxwell's theory. The quantum-mechanical view is given about the particle aspect of Maxwell's equations. The photon is an object with spin one and zero rest mass and it is shown that Maxwell's equations can be understood in a very direct way as field equations for such a particle. There is a complete parallel between Maxwell's equations and the quantum-mechanical field equations for the other elementary particles. (J.C.W.)

38614 DERIVATION OF THE BELL–HIROTA REPRESENTATION OF THE PARTITION FUNCTION FOR INTERACTING BOSONS. Jalickee, J. B.; Wiegel, F. W. (Northwestern Univ., Evanston, Ill.). Physica; 48: 589-96(30 Sep 1970).

A simple representation of the partition function for interacting bosons was derived by Bell and Hirota. They used methods of second quantization and the equivalence between Matsubara averages and averages over Gaussian random functions, which was pointed out by Bogolyubov. A derivation of this representation is given that entirely by-passes the formalism of second quantization and uses methods of functional calculus only. (auth)

38615 RELAXATION OF THE LONGITUDINAL MAGNETIZATION OF THE X–Y MODEL. van Vianen, H. A. W. (Univ., Utrecht); Tjon, J. A. Physica; 48: 487-508(30 Sep 1970).

The relaxation of the longitudinal magnetization of the X–Y model, after a sudden change of the external field, is examined in some detail. It is shown that, although the linear response theory of Kubo and Tomita is an excellent approximation at high temperatures, it breaks down at low temperatures. Also, the relaxation was studied for large times in the weak-coupling case, i.e., for small anisotropy, and it is shown to be almost exponential only when the external field $H = 2J/g\mu_B$. (auth)

38616 QUATERNION METHOD OF SEPARATION OF VARIABLES. Hautot, A. P. (Univ. Liege, Sart Tilman, Belgium). Physica; 48: 609-19(30 Sep 1970). (In French).

It is shown how the use of quaternions allows a direct integration by separation of variables of systems of partial differential equations. It follows that the resolution of Maxwell's or Dirac's equations is considerably simplified and made uniform. As an example, the method is applied to Dirac's hydrogenoid atom and to the corresponding selection rules. (auth)

38617 INDIRECT EXCHANGE INTERACTION IN TERMS OF AN EXACTLY SOLUBLE MODEL. Vertogen, G. (Rijks-Univ., Groningen, Netherlands). Physica; 48: 509-27(30 Sep 1970).

An exactly soluble model was formulated for the case of two localized magnetic moments with spin $S = \frac{1}{2}$ in ferro- or antiferromagnetic s–f or s–d interaction with a conduction-electron gas. This indirect exchange interaction model shows important differences between a ferro- and antiferromagnetic s–f interaction; e.g., in case of an antiferromagnetic s–f interaction both magnetic moments are never coupled in a purely ferromagnetic way. The model also exhibits the feature that, in case the distance between both moments satisfies a special condition, the correlation between these moments disappears, i.e., the indirect exchange interaction equals zero for these distances. (auth)

38618 STRIPPING OF ELECTRONS FROM NEGATIVE IONS IN CONSTANT MAGNETIC FIELD. Nikishov, A. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1614-20(May 1971). (In Russian).

The differential probability for stripping of an electron from a negative ion moving in a magnetic field is obtained. The effect of a change of the statistical weight of the final electron state in a strong magnetic field on electron detachment due to some force is considered. (auth)

38619 PARAPARTICLES ARE NOT IDENTICAL. Simonius, M. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett.; 33A: 59-60(21 Sep 1970).

It is shown that only bosons and fermions obey the indistinguishability requirement that all observables must be invariant under permutation of identical particles. (auth)

38620 POSITIVE-ENERGY RELATIVISTIC WAVE EQUATION. Dirac, P. A. M. (Florida State Univ., Tallahassee). Proc. Roy. Soc. (London), Ser. A; 322: No. 1551, 435-45(4 May 1971).

The relativistic wave equations currently used in physical theory are symmetrical between positive and negative energies. A new relativistic wave equation for particles of nonzero rest-mass is proposed, allowing only positive values for the energy. There is formal similarity between it and the usual relativistic wave equation for the electron, but the physical significance is very different. In particular, the new equation gives integral values for the spin. (auth) (UK)

38621 NEW METHOD IN THE WKB APPROXIMATION. Engelke, Raymond Pierce. Albuquerque, N. Mex.; Univ. of New Mexico (1970). 213p. University Microfilms Order No. 71-12,776.

Thesis.

A new WKB-like quantization rule is developed by means of a transformation method. This method makes use of a combination of a Liouville-like substitution and the Prüfer transformation. The only quality required of the potential is that it be twice differentiable on the real axis. The new quantization rule is an exact rule. However, some terms in the rule must be approximated before it can be evaluated for any particular potential function. An interesting feature of the derivation is that no asymptotic expansions are used—unlike the usual development of the first-order WKB quantization rule (FWKBQR). The terms corresponding to those of the FWKBQR can be isolated in the new exact rule. This feature offers the possibility of determining rigorous error bounds on the first-order WKB quantum number. Error bounds are derived on the first-order WKB quantum number for the potential $V(x) = kx^n$ with n = 2, 4, 6, 8, 12, and 16. It is shown that an upper bound on the first-order quantum number error for this type of potential is $\frac{1}{2}$ of a quantum number. This reaffirms a result of Titchmarsh. The lower error bounds are determined at "low" energies and they are more loose than the upper bound error. Graphs of these results are included. A new approximate quantization rule is derived from the exact rule. This new approximate rule can be evaluated by the same numerical procedures which are used to evaluate the FWKBQR. The new rule is used to determine energy eigenvalues and first-energy differences for the potential $V(x) = kx^n$ with n = 2, 4, 6, 8, 12, and 16. The new results are compared with the previously known exact and first-order WKB results. In addition, the new rule is numerically tested on some oscillators that approximate a square well, and comparisons are made with the exact square well energy values. Except for the case of the harmonic oscillator (where the FWKBQR gives exact results), the new rule is found to be generally superior to the FWKBQR both in its prediction of energies and of energy differences for the potentials tested. In addition, the new rule gives highly accurate results for the harmonic oscillator. Tables of these results are presented. (Diss. Abstr. Int., B)

38622 EINFUEHRUNG IN DIE THEORETISCHE PHYSIK. BAND I. (Introduction to Theoretical Physics. Volume I). Schaefer, Clemens. Berlin; Walter de Gruyter and Company (1970). 625p. DM 135,-.

Topics covered include: mechanics of a mass point (kinematics, dynamics, uses, and examples); mechanics of the point system (dynamics, principles of mechanics, Hamiltonian mechanics, uses and examples); mechanics of rigid bodies (kinematics, dynamics, uses, and examples); mechanics of deformable bodies (elastomechanics, hydromechanics, deformation states, stress states, motion of deformed bodies); elastomechanics (elastostatics, elastodynamics, uses, and examples); hydromechanics (hydrostatics, hydrodynamics of ideal fluids, hydrodynamics of viscous fluids, uses, and examples). (M.C.G.)

38623 WKB AND AN INTEGRAL FORMULATION OF THE SCHROEDINGER EQUATION. Baird, Leemon Claude Jr. Bloomington, Ind.; Indiana Univ. (1970). 117p. University Microfilms Order No. 71-12,442.

Thesis.

The WKB approximation is usually presented in an awkward language of asymptotic expansions. And there is no universally agreed-upon WKB theory in three dimensions. Two alternative WKB theories are presented. The first alternative is patently one-dimensional. The second may be applied in one, two, or three dimensions. In the first instance, the one-dimensional, time-independent Schroedinger equation is rewritten as a pair of coupled integral equations. The equations are solved by an iterative process, the zeroth-order solution being the WKB approximation. The iterative solution is extended to cover cases in which the usual WKB techniques falter or fail (e.g., classical turning points, discontinuous potentials, the radial equation). The iterative solution appears to converge rapidly; and the higher-order corrections can be interpreted in terms of multiple reflections. It is shown that the preceding approach is not readily generalized to the three-dimensional case. (TSS) (Diss. Abstr. Int., B)

38624 QUANTUM MECHANICS WITH CONSTRAINTS. Jensen, H. (Univ., Heidelberg); Koppe, H. Ann. Phys. (N. Y.); 63: No. 2, 586-91(Apr 1971).

The classical motion of a particle on a surface is simulated in quantum mechanics by forcing the particle to move between two parallel surfaces with separation d. In the limit $d \to 0$ one obtains an equation that differs from the equation proposed originally by Schroedinger by an additional potential that depends on the curvature of the surface. (auth)

38625 PROPERTIES OF MULTI-PARTICLE SPACES. Kelson, I.; Shadmon, G. (Tel-Aviv Univ., Israel). Ann. Phys. (N. Y.); 63: No. 2, 497-519(Apr 1971).

Many-fermion spaces are investigated with emphasis on the role of independent-particle motion. A "determinantal measure" is introduced, and its mathematical properties are analyzed. The relation to Hartree–Fock theory is discussed. Possible extensions are described, and their significance is pointed out. (auth)

38626 SIMPLIFIED VERSION OF THE RANDOM-PHASE APPROXIMATION AND THE PROBLEM OF THE CORRELATION ENERGY OF A MANY-FERMION SYSTEM. da Providencia, J. (Univ., Coimbra). Port. Phys.; 5: No. 4, 125-38(1969-1970).

A discrepancy between the formula for the correlation energy of a many-fermion system derived by the conventional random phase approximation (RPA) method and the corresponding expression derived by summation of perturbation-theory bubble diagrams is investigated. It is shown that this discrepancy is absent from a simplified version of the RPA dealing only with collective excitations. As an example, the new version of the RPA is applied, with good results, to the electron gas. (auth)

38627 DECOUPLING OF CHAINS OF EQUATIONS FOR TWO-TIME GREEN FUNCTIONS. Tserkovnikov, Yu. A. (Mathematics Inst., Moscow). Teor. Mat. Fiz.; 7: No. 2, 250-61(May 1971). (In Russian).

Various ways are considered for constructing solutions of chains of equations for two-time Green's functions; these methods make it possible to obtain easily the expressions for damping and elementary excitation energy. Examples of the one-particle Green's function and the matrix Green's function, used in the theory of superfluidity and superconductivity, are considered as the illustrations. (auth)

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PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 38680 and 38819.

38628 (LNF-70/59) EXPERIMENTAL ACTIVITES AT BONN, HIGH ENERGY EXPERIMENTS BELOW 1 GeV. von Holtey, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Dec 1970. 28p. (CONF-701121-2). Dep. NTIS (U. S. Sales Only).

From Meeting on electronsynchrotron, Frascati, Italy (5 Nov 1970).

The experimental facilities and the high-energy research programs (up to 1 GeV) at the Bonn 500-MeV and 2.5-GeV electron synchrotrons are described. (W.H.K.)

38629 EVOLUTION OF PARTICLE PHYSICS. A Volume Dedicated to Edoardo Amaldi in His Sixtieth Birthday. Conversi, M. (ed.). New York; Academic Press Inc. (1970). 364p. $19.50.

Separate abstracts were prepared for 22 of the 23 papers included. The remaining paper is outside the scope of NSA. (J.W.R.)

For abstracts of individual papers see: 38079, 38545, 38642, 38649, 38681–38684, 38690, 38713, 38714, 38753, 38759, 38762–38764, 38770, 38777, 38819, 38820, 38999, and 39072.

38630 COMPTES RENDUS DU 92e CONGRES NATIONAL DES SOCIETES SAVANTES. TOME 2. (Proceedings of the 92nd National Congress of the Learned Societies. Volume 2). Proceedings Held at Strasbourg and Colmar, France, 31 March–4 April 1967. Paris; Bibliotheque Nationale (1970). 570p. (CONF-670342-(Vol.2)).

The 48 papers appearing in this volume treat the following subjects: astronomy, mathematics, physics, mineralogy, and geology. Ten of the papers were abstracted, nine from the physics chapter and one from the mineralogy and geology chapter. (France)

For abstracts of individual papers see: 37477, 37602, 37603, 37632, 38138, 38560, 38637, 38655, 38942, and 38943.

38631 CORRELATIONS BETWEEN THE MOMENTUM AND ANGULAR CHARACTERISTICS IN INELASTIC INTERACTIONS AT $0.5(10)^{12}$ eV. Berdzenishvili, O. L.; Gabuniya, L. L.; Garibashvili, D. I.; (and others) (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 13: No. 4, 772-8(Apr 1971). (In Russian).

The correlations between the momentum and angular characteristics in inelastic interactions at $0.5(10)^{12}$ eV in c.m.s of charged particles are obtained. It is shown that the correlations observed can be explained by the thermodynamical model which takes into account the collective motion of hadron matter along the collision axis. (auth)

Electromagnetic

38632 (CERN-HERA-70-1) A COLLECTION OF PION PHOTOPRODUCTION DATA. I. FROM THE THRESHOLD TO 1.5 GeV. Spillantini, P.; Valente, V. (European Organization for Nuclear Research, Geneva (Switzerland)). 6 Jun 1970. 155p. Dep. NTIS (U. S. Sales Only).

A complete and computerized collection of pion photoproduction data on differential cross sections, recoil polarization, and asymmetry ratio with polarized gamma rays from threshold to 1.5 GeV is presented. (J.F.P.)

38633 (LAL-1251) MEASUREMENT OF THE RATIO OF POSITRON-PROTON AND ELECTRON-PROTON ELASTIC SCATTERING CROSS SECTIONS AT 180^0 AT LARGE q^2. Bouquet, B. ([Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire]). Apr 1971. 117p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The real part of the amplitude of elastic scattering of electrons and positrons on protons with several photons exchanged was measured, and the results are given for energies of 380 and 980 MeV at 180°. The ratio of cross sections of positron to electron scattering was found to be 1.038 ± 0.016 at 400 MeV and 1.058 ± 0.05 at 1 GeV. (J.F.P.)

38634 (PURC-4159-29) NEUTRAL DECAYS OF THE η^0, ω^0, AND X^0 MESONS. Kreisler, Michael N. (Princeton Univ., N. J. Dept. of Physics). [1971]. 20p. (CONF-710421-1). Dep. NTIS.

From International conference on meson resonances and related electromagnetic phenomena; Bologna, Italy (14 Apr 1971).

The results of a series of experiments that were performed recently at the Princeton-Pennsylvania Accelerator to study the neutral decays of the η and ω mesons are described. In these experiments, the mesons were produced in the reaction

$$\pi^- p \rightarrow \left\{ \begin{matrix} \eta \\ \omega \\ X^0 \end{matrix} \right\} + n.$$

The production of the meson was identified by measuring the momentum and angle of the neutron using large liquid scintillation counters. Single gammas from the neutral decays of the mesons were then momentum analyzed in a spark chamber-magnet spectrometer and transformed to the center of mass of the meson. After background subtraction, the momentum spectrum allows identification of the various decay modes as well as a calculation of the branching ratios. (auth)

38635 POLARIZATION OF PROTONS PRODUCED IN THE $\gamma + n \rightarrow \pi^- + p$ REACTION FOR PHOTON ENERGIES BETWEEN 550 AND 900 MeV. Goncharov, N. V.; Derebchinskii, A. I.; Zybalov, A. A.; (and others) (Physical-Tech. Inst., Kiev). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1561-8(May 1971). (In Russian).

A telescope of spark chambers and scintillation counters is used for measuring the polarization of photoprotons from the ^{12}C nucleus for γ quantum energies E_γ^{max} = 650 to 1000 MeV. The experimental data are employed for calculating the polarization of protons from the $\gamma + n \rightarrow \pi^- + p$ reaction for photon energies between 550 and 900 MeV under the assumption that the major mechanism of photoproduction of protons in a nucleus in the kinematic region of π meson photoproduction is the photoproduction of π mesons on quasi-free nucleons of the nucleus. The energy variation of polarization of $\gamma + n \rightarrow \pi^- + p$ protons possesses a structure and changes sign at a photon energy of 735 MeV. Between the P_{33} and D_{13} resonances the polarization energy variation satisfactorily agrees with the theoretical course in which contribution of P_{11} resonance is taken into account. (auth)

38636 TEST OF QUANTUM ELECTRODYNAMICS BY BHABHA SCATTERING IN THE GeV REGION. Borgia, B. (Univ., Rome. IFNF, Rome); Ceradini, F.; Conversi, M.; (and others). Phys. Lett.; 35B: No. 4, 340-4(7 Jun 1971). (7 Jun 1971).

Electron–positron elastic scattering was investigated experimentally using colliding beams of total energy ranging from 1.4 to 2.4 GeV. The results, based on the analysis of 3255 wide angle scattering events, agree with the predictions of quantum electrodynamics up to the highest space-like momentum-transfers involved. (auth)

38637 NEUTRAL PION PHOTOPRODUCTION WITH HYDROGEN. Croissiaux, Michel (Univ., Strasbourg). pp 245-9 of Comptes Rendus du 92e Congres National des Societes Savantes. Tome 2. Paris; Bibliotheque Nationale (1970). (In French).

From ninety-second national congress of the Learned Societies; Strasbourg, France (31 Mar 1967). See CONF-670342-(Vol. 2).

A neutral pion photoproduction experiment with hydrogen is described for photon energies corresponding to the first pion nucleon resonance. The reasons why pion emission at 180° was studied are exposed. The special apparatus needed to measure absolute cross sections at this angle is described. The methods used are indicated. The results led to a preliminary determination of the amplitude of certain multipoles. (France)

38638 FORWARD COMPTON SCATTERING FROM HYDROGEN AND DEUTERIUM AT 8 AND 16 GeV. Boyarski, A. M.; Coward, D. H.; Ecklund, S.; (and others) (Stanford Univ., Calif.). Phys. Rev. Lett.; 26: No. 25, 1600-3(21 Jun 1971).

Compton-scattering cross sections from hydrogen ($\gamma p \rightarrow \gamma p$) and from deuterium were measured at four-momentum transfer t in the range $0.014 \leq -t \leq 0.17$ GeV^2 and photon energies of 8 and 16 GeV. Fits to our proton data of the form $d\sigma/dt = Ae^{Bt}$ give $B \approx 7.8$ GeV^{-2} and an intercept A which is in agreement with the optical point. Both coherent scattering from deuterons and incoherent scattering from neutrons and protons are seen from deuterium. A small difference between the neutron and proton cross sections is seen, indicating the presence of about a 3% isovector t-channel exchange amplitude in addition to the predominant isoscalar ampli-

tude. The vector-dominance model predicts lower cross sections (by at least 20%) for both the hydrogen and deuterium cases. (auth)

38639 PHOTOPRODUCTION OF φ^0 MESONS FROM HYDROGEN AND CARBON BY LINEARLY POLARIZED PHOTONS. McClellan, G. (Cornell Univ., Ithaca, N. Y.); Mistry, N.; Sandler, B.; (and others). Phys. Rev. Lett.; 26: No. 25, 1597-1600(21 Jun 1971).

Results are presented on the forward photoproduction of φ^0 mesons from hydrogen and carbon by linearly polarized photons from coherent bremsstrahlung produced by 10-GeV electrons on a diamond crystal. The polarization asymmetry was measured at an average energy $\langle E_\gamma \rangle \approx 5.7$ GeV. The asymmetry from carbon is consistent with a diffractive production process. The asymmetry from hydrogen seems to be inconsistent with a purely diffractive production process even after consideration of inelastic contributions to the forward φ^0 production. (auth)

38640 PHOTOPRODUCTION OF φ^0 MESONS FROM HYDROGEN, DEUTERIUM, AND COMPLEX NUCLEI. McClellan, G.; Mistry, N.; Mostek, P.; (and others) (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 26: No. 25, 1593-6(21 Jun 1971).

The photoproduction of φ^0 mesons from hydrogen, deuterium, and complex nuclei was measured at energies from 6.4 to 9.0 GeV. Results are presented on the t dependence from hydrogen and carbon. Forward cross sections for φ^0 photoproduction from D_2, C, Mg, Cu, Ag, and Pb are analyzed in terms of the φ^0-photon coupling constant, the φ-nucleon total cross section, and the real part of the φ-nucleon scattering amplitude. (auth)

38641 NEUTRON CHARGE FORM FACTOR FROM THE PION ELECTROPRODUCTION NEAR THRESHOLD. Titov, Yu. I.; Severin, N. F.; Afanas'ev, N. G.; (and others) (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: 541-50(Mar 1971). (In Russian).

Results are presented of measurements of pion electroproduction near threshold at electron energies of 1000 to 1170 MeV and scattering angles 16 to 25°. The data are analyzed in the S-wave Born approximation at threshold, as well as by the isobaric model. The isobaric-model parameters are improved to make it possible to apply the model to the description of the cross section near threshold. A value of the neutron charge form factor is obtained that is constant inside the interval of the four-momentum transfers (2.5 to 5)F^{-2} and equal to -0.19 ± 0.07. (auth)

Weak

Refer also to abstract 38863.

38642 $K_L - K_S$ MASS DIFFERENCE. Rubbia, C. (CERN, Geneva). pp 257-67 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

The review of the $K_2 - K_1$ mass difference covers the measurement of the mass difference, single regenerator experiments, the $K_2 - K_1$ interference in the $\pi^+\pi^-$ decay channel, and the gap and zero-cross methods for experiments with two regenerators. (J.F.P.)

38643 OBSERVATION OF THE RADIATIVE ELECTRONIC DECAY MODE OF THE LONG-LIVED NEUTRAL K MESON. Peach, K. J. (Univ. of Edinburgh); Evans, G. R.; Muir, J.; (and others). Phys. Lett.; 35B: No. 4, 351-4(7 Jun 1971).

The first observation of the radiative electronic decay of the K_L^0 ($K_L^0 \rightarrow \pi e \nu \gamma$) is reported, and the results are compared with theoretical models for the decay. (auth)

38644 ANALYSIS OF SPIN CORRELATIONS IN THE β DECAY OF THE Λ HYPERON. Garcia, Augusto (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., D; 3: No. 11, 2638-48(1 Jun 1971).

Recent experimental data on the β decay of the Λ are analyzed. Integrated expressions for the measured quantities in terms of form factors are given up to second order in the parameter $\beta = (m_\Lambda - m_p)/m_\Lambda$. The sensitivity of these experimental quantities as functions of specific form factors is studied in detail and exhibited in a form which is useful for the analysis of present experiments and for the planning of future ones. Within the framework of V − A theory, the possibility is explored that the data require the presence of an induced pseudo-tensor form factor. Qualitative discussions of the q^2 dependence of some form factors and of possible admixtures of scalar and tensor interactions are also given. (auth)

38645 NEUTRON PRODUCTION FROM Pb, Cd, Fe, Al, AND FISSION OF Pb NUCLEI BY COSMIC RAYS WITHIN THE DEPTHS 0 TO 1000 mwe. Gorshkov, G. V.; Zyabkin, V. A.; Yakovlev, R. M. Yadern. Fiz.; 13: No. 4, 791-6(Apr 1971). (In Russian).

The neutron production in Pb, Cd, Fe, and Al was investigated induced by the cosmic ray μ mesons at the depths of 40 and 80 m wat. eq. The mean values for the product of the interaction cross section and for the neutron production multiplicity for the given elements and depths are given. The velocities of the neutron production in Pb, Cd, Fe, and Al induced by the high-energy μ mesons and slow negative μ mesons are calculated. The theoretical calculation $\bar{\sigma\nu}/A$ for Pb at the depths of 40 and 80 m wat. eq. is performed. The velocity of the cosmic ray fission of Pb by the nucleon and μ-meson component is calculated for the depths of 0 to 1000 m wat. eq. (auth)

Strong (Baryon-Induced)

Refer also to abstract 37644.

38646 (CERN-HERA-69-3) COMPILATION OF TOTAL AND TOTAL ELASTIC CROSS-SECTIONS. Giacomelli, G. (European Organization for Nuclear Research, Geneva (Switzerland)). 2 Dec 1969. 35p. Dep. NTIS (U. S. Sales Only).

A computerized collection of total, total elastic and total charge exchange data on hadron-nucleon scattering is presented. Also given are interpolated values of the data. (auth)

38647 (CERN-HERA-70-3) COMPILATION OF CROSS SECTIONS. II. ANTIPROTON INDUCED REACTIONS. Flaminio, E.; Hansen, J. D.; Morrison, D. R. O.; Tovey, N. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct 1970. 113p. Dep. NTIS (U. S. Sales Only).

A compilation of cross sections of reactions produced by antiprotons on targets of protons, neutrons and deuterons is presented. Graphs of the variation of cross section with incident laboratory momentum are plotted. Values for the rate of decrease of cross section with incident momentum are given. (auth)

38648 (UCRL-20000 YN) COMPILATION OF YN REACTIONS. Benary, Odette; Barash-Schmidt, Naomi; Price, LeRoy R.; Rosenfeld, Arthur H. (California Univ., Berkeley. Lawrence Radiation Lab.); Alexander, Gideon (Tel Aviv Univ. (Israel)). Jan 1970. 75p. Dep. NTIS.

There are compiled 17 papers reporting Λp, $\Sigma^+ p$, and $\Sigma^- p$. Cross sections, angular distributions, and polarizations are displayed. Included are indices to the papers, as well as a complete listing of the selected YN data. The cutoff date for this report was 1 January 1970. (auth)

38649 $K^0 - \bar{K}^0$ SYSTEM IN $p-\bar{p}$ ANNIHILATION AT REST. Goldhaber, M. (Brookhaven National Lab., Upton, N. Y.); Yang, C. N. pp 171-5 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

A discussion is given of experiments for the study of the $K^0 - \bar{K}^0$ system produced in $\bar{p} + p$ interactions at rest. Experiments requiring the detection of K^0 and experiments requiring the detection of two K^0's are considered. (J.F.P.)

38650 OBSERVATION OF SMALL ANGLE PROTON-PROTON ELASTIC SCATTERING AT 30 GeV AND 45 GeV CENTER OF MASS ENERGIES. Holder, M. (Technische Hochschule, Aachen); Radermacher, E.; Staude, A.; (and others). Phys. Lett.; 35B: No. 4, 355-60(7 Jun 1971).

Small angle elastic scattering events were observed at the CERN Intersecting Storage Rings. Directions of both particles as well as the collision vertex are reconstructed with the help of four sets of spark chambers, two for each of the two arms. The elastic nature of the events is demonstrated by a collinearity requirement. Values for the (diffraction) slope parameter are found in disagreement with the simple linear extrapolation of lower energy (Serpukov) data. (auth)

38651 DETERMINATION OF THE PROTON-PROTON ELASTIC CROSS SECTION AT 30 GeV CENTER OF MASS ENERGY. Holder, M. (Technische Hochschule, Aachen); Radermacher, E.; Staude, A.; (and others). Phys. Lett.; 35B: No. 4, 361-4(7 Jun 1971).

The absolute luminosity of the CERN Intersecting Storage Rings was determined by the Van der Meer method. Combining the measurement with small angle proton−proton elastic events, $\sigma_{elastic} = (6.8 \pm 0.6)$ mb is found. (auth)

38652 OBSERVATION OF THE d^* EFFECT IN THE $\bar{p}d \rightarrow p\bar{p}\pi^+\pi^- n$ REACTION AT 5.55 GeV/c. Braun, H.; Evrard, D.; Fridman, A.; (and others) (Centre de Recherches Nucleaires, Strasbourg). Phys. Rev., D; 3: No. 11, 2572-7(1 Jun 1971).

This experiment is based on 150,000 photographs, taken at the Zero Gradient Synchrotron with the 30-in. bubble chamber. Re-

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sults are presented on a subsample of $p_s \bar{p}\pi^+\pi^-$ n events in which the protons stopping in the chamber do not show the characteristic nucleon-spectator behavior. The selection procedure for this sample is discussed. A strong low-mass $p_s n\pi^+$ enhancement at 2.2 GeV/c^2 is observed. This bump is not considered as a real resonance and is interpreted as having the same origin as the 2.2-GeV/c^2 dπ enhancement observed, for instance, in the $\bar{p}d \rightarrow \bar{p}d\pi^+\pi^-$ reaction at the same energy. (auth)

38653 ATTEMPT TO DETERMINE THE ELASTIC PROTON–NUCLEON CROSS SECTION AT 83 GeV. Goza, E. R.; Stafford, E. G. (Louisiana State Univ., Baton Rouge). Phys. Rev., D; 3: No. 11, 2577-81(1 Jun 1971).

An attempt was made to measure the proton–nucleon elastic cross section using primary cosmic-ray protons with a mean energy of 83 GeV. A total of 10 m of primary proton tracks was line-scanned for stars resulting from elastic scatterings on nucleons bound in emulsion nuclei. The probability of detecting an elastic scatter in emulsion is considered using an analysis similar to that of McCusker. Two elasticlike scatters were found, but these can be shown to be random track-intersection coincidences, consistent with the number of proton recoils expected from neutron stars. No elastic scatters in a path length of 10 m have been found. A Monte Carlo analysis, modeled after the suggestions of Goldberger and the calculations performed by Bernardini, was used to calculate the probability of obtaining an observable proton associated with an elasticlike event in photographic emulsion. This analysis of the detection probability of an elastic scatter indicates that the proton–nucleon elastic cross section at 83 GeV is no greater than 3 mb with 95% probability. (auth)

38654 SEARCH FOR THE INTERMEDIATE VECTOR BOSON. Ankenbrandt, C. M. (Brookhaven National Lab., Upton, N. Y.); Larsen, R. C.; Leipuner, L. B.; (and others). Phys. Rev., D; 3: No. 11, 2582-2603(1 Jun 1971).

A search for the vector boson (W particle), postulated as the mediator of the weak interaction, was carried out by determining the intensity and polarization of muons originating very near the point of interaction of 28-GeV protons with nucleons. Bosons were not observed and the upper limit on the production cross section for W's with masses between 2.0 and 4.5 GeV/c^2 is $B\sigma_W \lesssim 6 \times 10^{-36}$ cm^2, where B is the branching ratio for the W decay to a muon and a neutrino. A comparison between the measured flux of muon pairs and the flux expected on the basis of a plausible model for the production and decay of both W's and heavy virtual γ's suggests that the experiment may not have been sensitive to W's, if they exist in this mass region. The flux of high-energy muons produced directly by an unknown process, an X process, is determined to be no greater than 10^{-6} times the pion flux. (auth)

38655 STUDY OF THE HYPERFRAGMENTS PRODUCED IN K-MESON INTERACTIONS WITH THE NUCLEI OF THE NUCLEAR EMULSION. Baumann, G.; Gerber, J. P.; Bechdolff, A.; Cuer, P. (CNRS, Strasbourg). pp 135-48 of Comptes Rendus du 92e Congres National des Societes Savantes. Tome 2. Paris; Bibliotheque Nationale (1970). (In French).

From ninety-second national congress of the Learned Societies; Strasbourg, France (31 Mar 1967). See CONF-670342–(Vol. 2).

Some experimental results are given from the study of hyperfragments produced by the following interactions with nuclear emulsions: the stopping of K^- mesons and the passage of 3.0 and 5.0 GeV/c K^- mesons. The respective rates of production were $(6.6 \pm 0.02)\%$, (2.5 ± 0.5), and $(1.8 \pm 0.3)\%$. The binding energies of certain light mesic fragments were determined and a kinematic analysis made of some three-body reactions, for example $^5He \rightarrow {}^4He + p + \pi^-$; it was noticed that this disintegration occurs through an intermediate $^5Li^*$ nucleus. Investigations into finding an excited $^9Be^*$ state were unsuccessful. In the K^- interactions at 3.0 and 5.0 GeV/c, three events with simultaneous hyperfragments emission, with a rate of production of 10^{-4}, were observed. These events are of interest in the study of Ξ and $\Lambda_0\Lambda_0$ hyperfragments and hence the Λ_0–Λ_0 potential. (France)

38656 FURTHER RESULTS ON MUONS STOPPING AT GREAT DEPTH. Baschiera, B. (CNR, Turin); Bergamasco, L.; Castagnoli, C.; Picchi; P. Lett. Nuovo Cim.; 1: No. 23, 961-6(5 Jun 1971).

Two new runs of measurements were carried out imposing stricter conditions for the study of an anomaly in the stopping muon rate underground. This anomaly is that the ratio R of the stopping muons S_μ to the traversing muons N_μ is higher than the value predicted by conventional processes. The results are $I(S_\mu) = (6.35 \pm 0.25)(10)^{-11}$ cm^{-2} s^{-1} sr^{-1} and the ratio R is $(1.19 \pm 0.41)(10)^{-2}$. It is estimated that the ratio of the number of directly produced stopping muons to the total flux of traversing muons is $R \sim n \cdot N_\mu \cdot \Delta x \cdot \sigma_\alpha$, where N is the Avogadro number. An indication of a cross section of the order of $\sim(10^{-28}$ to 10^{-29} cm$^2)$ is found. (J.F.P.)

38657 SEARCH FOR A NEW TYPE OF RADIOACTIVITY IN ALUMINUM AND TUNGSTEN TARGETS IRRADIATED BY 70-GeV PROTONS. Dem'yanov, A. V.; Kulikov, A. V.; Kuptsov, A. V.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 4, 786-90(Apr 1971). (In Russian).

In preceding work a method has been proposed suitable for searching for hypothetical quasi-stable elementary particles which might be produced in high energy collisions. The first results of the search for a radioactivity with the emission of high energy gamma quanta from targets irradiated for a long time by 70-GeV protons at Serpukhov are given. Lifetimes in the range from one day to several years are considered. No events with gamma-emission are observed. The upper limits of the nuclear cross section for production by 70-GeV protons of the "radioactive" quasi-nucleus emitting the high-energy photons are $10^{-38} - 10^{-37}$ cm^2 for Al and $10^{-36} - 10^{-35}$ cm^2 for W. (auth)

Strong (Meson-Induced)

38658 (CERN-HERA–70-4) COMPILATION OF CROSS SECTIONS. III. K^+ INDUCED REACTIONS. Flaminio, E.; Hansen, J. D.; Morrison, D. R. O.; Tovey, N. (European Organization for Nuclear Research, Geneva (Switzerland)). Sep 1970. 88p. Dep. NTIS (U. S. Sales Only).

A compilation of cross sections of reactions produced by positive kaons on targets of protons, neutrons and deuterons is presented. Graphs of the variation of cross section with incident laboratory momentum are plotted. Values for the rate of decrease of cross section with incident momentum are given. (auth)

38659 (CERN-HERA–70-5) COMPILATION OF CROSS SECTIONS. IV. π^+ INDUCED REACTIONS. Flaminio, E.; Hansen, J. D.; Morrison, D. R. O.; Tovey, N. (European Organization for Nuclear Research, Geneva (Switzerland)). Sep 1970. 120p. Dep. NTIS (U. S. Sales Only).

A compilation of cross sections of reactions produced by positive pions on targets of protons, neutrons and deuterons is presented. Graphs of the variation of cross section with incident laboratory momentum are plotted. Values for the rate of decrease of cross section with incident momentum are given. (auth)

38660 (ITEF–790) DECK'S EFFECT IN THE REACTION $\pi^-p \rightarrow \rho^0\pi^-p$ AT 4.45 GeV/c. Beketov, G. V.; Zombkovskii, S. M.; Kaidalov, A. B.; Konovalov, B. S.; Kruchinin, S. P.; Selektor, Ya. M.; Shulyachenko, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 23p. (In Russian). Dep. NTIS (U. S. Sales Only).

The reaction $\pi^-p \rightarrow \rho^0\pi^-p$ at 4.45 GeV/c was studied in the ITEP 50 cm liquid–hydrogen bubble chamber. The $\pi\rho$ effective mass distribution for $|t_\rho| < 0.5$ (GeV/c)^2 (where t is a squared four momentum transfer to ρ-meson) has a maximum in an A_1-meson region. The distribution is in good agreement (in absolute values) with the calculated results through a Regge π-pole exchange model. The $\pi\rho$ effective mass distribution for events with $|t_\rho| > 0.5$ (GeV/c)^2 is well described by a phase space invariant curve added to a Breit–Wigner curve. For events from the reaction $\pi^-p \rightarrow \rho^0\pi p$ with $|t| < 0.5$ (GeV/c)^2 the angular distribution of the system in an A_1-meson mass region is in agreement with the expected one for the particle decay with quantum numbers $J^P = 1^+$ and for the angular distribution calculated through a Regge π-pole exchange mode. (auth)

38661 (LAL-RI–71-2) ANALYSIS OF THE $K^-p \rightarrow \Lambda^0\pi^+\pi^-$ REACTION AND THE SEPARATION OF THE K^-p INTERACTIONS FROM THE K^- NUCLEUS INTERACTIONS IN A HEAVY LIQUID BUBBLE CHAMBER. Ferrer-Soria, A. (Paris Univ., Orsay (France). Faculte des Sciences). Mar 1971. 73p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The formation of baryon resonances in the K^-p interaction around 1660 MeV in the center of mass system, and their decay into various neutral channels such as $\Lambda^0\pi^0$, $\Sigma^0\pi^0$, and $\Lambda^0\pi^0\pi^0$ were studied. A bubble chamber filled with a C_3H_8 + C F_3 Br mixture was used. The reaction $K^-p \rightarrow \Lambda^0\pi^+\pi^-$ was analyzed in order to determine the possibility of separating K^-p interactions from K^- nucleus interactions and to estimate the corresponding background. The mean life of Λ^0 was measured and the cross section of the reaction $K^-p \rightarrow \Lambda^0\pi^+\pi^-$ was calculated. The presence of the $Y_1^{*-}(1385)$ and $Y_1^{*+}(1385)$ resonances was revealed. The results are compatible with those measured in other experiments performed with hydrogen. It was thus

proved that the separation of K^-p interactions from K^- nucleus interactions is possible. (France)

38662 (NP-18891) K^-d AND K^-n INTERACTIONS AT ABOUT 1 GeV/c. Narjoux, Jean-Louis (Paris Univ. (France). Faculte des Sciences). 1970. 147p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

$K^-d \rightarrow K^-d$ and $K^-n \rightarrow K^-n$ interactions were studied in the 1 GeV/c region. Cross sections and angular distributions were measured. They are in good agreement with the simplified model of Bertocchi. The study of the $K^-d \rightarrow p\Lambda\pi^-$ reaction enabled the validity of the impulse approximation for K^-d interactions at these energies to be established. A method for identifying the spectator nucleon was developed in the framework of this approximation. In events involving a dissociated deuteron in the final state, two samples were isolated, one with a neutron spectator, the other with a proton spectator. In the case of a neutron spectator the results obtained for the elastic K^-p reaction are in good agreement with previous results. The method enabled the $K^-n \rightarrow K^-n$ angular distribution to be determined directly in the angular interval −1 to 0.7. Experimental results with hydrogen are in agreement with the T = I scattering amplitude although the O^0 amplitude seems to be slightly overestimated. (France)

38663 (UCRL-20001) COMPILATION OF ELASTIC SCATTERING DATA. Fox, Geoffrey C.; Quigg, C. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan 1970. 36p. Dep. NTIS.

Data for elastic scattering of π^+, π^-, K^+, K^-, p, and $\bar{p}$ on protons are presented in figures and tables. (auth)

38664 ANALYSIS OF THE LOW-MASS $K\pi\pi$ ENHANCEMENT. Forman, B.; Gelfand, N. M.; Leary, P.; (and others) (Univ. of Chicago). Phys. Rev., D; 3: No. 11, 2610-19(1 Jun 1971).

The reaction $K^+p \rightarrow K^+p\pi^+\pi^-$ at 4.3 BeV/c was studied to investigate the nature of the low-mass $K\pi\pi$ enhancement. It is found that the enhancement decays principally into $K^*(890)\pi$ with the $K^*(890)$ alignment the same as for the $K^*(890)$ from the final state $K^*(890)N^*(1236)$. The similar $K^*(890)$ decay distributions in the two distinct samples of events are interpreted as further support for the hypothesis that the Q enhancement is due to a Deck-type mechanism. (auth)

38665 π^-p ELASTIC SCATTERING IN THE c.m. ENERGY RANGE 1400 TO 2000 MeV. Brody, A. D. (Stanford Univ., Calif.); Cashmore, R. J.; Kernan, A.; (and others). Phys. Rev., D; 3: No. 11, 2619-37(1 Jun 1971).

Total and differential cross sections for π^-p elastic scattering are presented at 35 energies between 1400 and 2000 MeV. (auth)

38666 INTERACTIONS OF NEUTRAL K MESONS IN HYDROGEN. Meisner, Gerald W. (Univ. of California, Berkeley. Univ. of North Carolina, Greensboro); Crawford, Frank S. Phys. Rev., D; 3: No. 11, 2553-60(1 Jun 1971).

The reaction $\pi^- + p \rightarrow \Lambda + K^0$ in the 72-in. hydrogen chamber was used to produce 7220 K^0 mesons associated with a visible decay $\Lambda \rightarrow p + \pi^-$. The time dependence and absolute yield of the subsequent strong interactions of K^0 and $\bar{K}^0$ in hydrogen were used to determine all the parameters of the neutral K system, without the assumption of CPT invariance or other assumptions about the weak interactions of neutral K's. From the time distribution of 59 events of the type $\bar{K}^0 + p \rightarrow$ hyperon, the magnitude of the $K_S^0 - K_L^0$ mass difference is found. The mixing parameters p, q, p′, q′ of the neutral K system are found by means of the time dependence and absolute yield of 11 charge-exchange events, $K^0 + p \rightarrow K^+ + n$, and the absolute yield of 49 two-body interactions, $\bar{K}^0 + p \rightarrow$ hyperon + pion. The results are consistent with CPT invariance and with values of the mixing parameters determined by means of weak interactions. The Biswas ratio $R \equiv \sigma(K_Lp \rightarrow K_Sp)/\sigma(K_Lp \rightarrow$ hyperon) was found to be $R = 0.41 \pm 0.13$ averaged over K_L momenta from about 200 to 600 MeV/c. This agrees with solution I of Kim and with the results of Kadyk et al. The absolute yields for $\bar{K}^0 + p \rightarrow$ hyperon + pion are in good agreement with the predictions of charge independence and the measured rates for $K^- + p \rightarrow$ hyperon + pion. For the front-back asymmetry of the Λ in $\bar{K}^0 + p \rightarrow \Lambda + \pi^+$, $(F-B)/(F+B) = -0.48 \pm 0.18$, indicating that the P wave cannot be neglected relative to the S wave in our momentum range. (auth)

38667 PRODUCTION AND DECAY OF THE $\phi(1680)$ IN $\pi^+d \rightarrow pp\pi^+\pi^-\pi^0$ AT 6.95 GeV/c. Matthews, J. A. J. (Univ. of Toronto); Prentice, J. D.; Yoon, T. S.; (and others). Phys. Rev., D; 3: No. 11, 2561-72(1 Jun 1971).

An analysis of the 1.68-GeV mass region of the $m(\pi^+\pi^-\pi^0)$ spectrum in our $\pi^+d \rightarrow pp\pi^+\pi^-\pi^0$ data confirms the existence of an $I^G = 0^-$ enhancement at this mass, the $\phi(1680)$, which is distinct from the $I = 1$ A_3 meson. This resonance was found to decay preferentially into $\rho\pi$ with a $3\pi/(3\pi + \rho\pi)$ branching ratio of <30%. A spin-parity analysis of the $\phi(1680)$ favors $J^P = 1^-, 2^+, 3^-$ for spins ≤3, although $J^P = 1^+, 2^-$ cannot be rigorously excluded. The mass and favored natural spin-parity of the $\phi(1680)$ suggest that it may be the Regge recurrence of the ω^0 meson. Assuming a natural-spin-parity assignment, the decay angular distributions of the $\phi(1680)$ suggest that there exists a contribution from unnatural-parity exchange in the production mechanism. The t dependence of the differential cross section and the energy dependence of the total cross section for $\pi^+n \rightarrow \phi(1680)p$ were found to be similar to those of $\pi^+n \rightarrow (\omega^0, A_3^0)p$ also seen in the data. As with these latter processes, the energy dependence of the cross section for $\pi^+n \rightarrow \phi(1680)p$ cannot be explained by simple ρ Regge exchange. The $I = 1$ $f^0\pi^0$ cross section in the A_3^0 mass region was found to be small, and suggests that the production cross section of the A_3 meson by charge exchange is significantly less than that observed in non-charge-exchange reactions such as $\pi^-p \rightarrow A_3^-p$. (auth)

38668 2130-MeV Λ^0p MASS ENHANCEMENT IN THE REACTION $K^- \rightarrow \Lambda^0p\pi^-$ AT 1.45 AND 1.65 GeV/c. Eastwood, D. (Univ. of Birmingham, Eng.); Fry, J. R.; Heathcote, F. R.; (and others). Phys. Rev., D; 3: No. 11, 2603-6(1 Jun 1971).

An enhancement in the Λ^0p mass spectrum from the reaction $K^-d \rightarrow \Lambda^0p\pi^-$ at K^- momenta of 1.45 and 1.65 GeV/c is reported. The peak of the distribution occurs at ≈2129 MeV and the width at half-height is ≈10 MeV. A possible interpretation of this effect is given. (auth)

38669 PRODUCTION OF B(1235) AND $\rho(1710)4\pi$ ENHANCEMENTS IN 16-GeV/c π^+p COLLISIONS. Ballam, J.; Chadwick, G. B.; Guiragossian, Z. G. T.; (and others) (Stanford Univ., Calif.). Phys. Rev., D; 3: No. 11, 2606-9(1 Jun 1971).

Production of B(1235) and $\rho(1710)$ mesons is observed in the four-pion decay modes $\pi^+\pi^+\pi^-\pi^0$ in 16-GeV/c π^+p collisions. Decay distributions and branching fractions into various modes are presented. Absence of the two-pion mode $\pi^-\pi^0$ for the $\rho(1710)$ is noted. (auth)

38670 SINGLE-PARTICLE DISTRIBUTIONS OF π MESONS PRODUCED IN π^+p, K^+p, pp, AND π^-p COLLISIONS AT HIGH ENERGIES. Chen, M.-S. (Brookhaven National Lab., Upton, N. Y.); Kinsey, R. R.; Morris, T. W.; (and others). Phys. Rev. Lett.; 26: No. 25, 1585-8(21 Jun 1971).

A comparison is made of single-particle momentum distributions of pions produced in 7.0-GeV/c π^+p, 12.7-GeV/c K^+p, 28.5-GeV/c pp, and 24.8-GeV/c π^-p interactions. It is observed that the distributions for negative pions which have low laboratory momentum (target fragments) in π^+p, K^+p, and pp interactions agree with each other when normalized by their respective asymptotic total cross sections. However, the corresponding distributions from the π^-p reaction are significantly different from the rest. This difference is particularly interesting in view of recent theoretical predictions for inclusive reactions. (auth)

38671 LONGITUDINAL- AND TRANSVERSE-MOMENTUM DISTRIBUTIONS FOR π^- MESONS IN 18.5-GeV/c π^+p INTERACTIONS. Biswas, N. N.; Cason, N. M.; Kenney, V. P.; (and others) (Univ. of Notre Dame, Ind.). Phys. Rev. Lett.; 26: No. 25, 1589-92(21 Jun 1971).

New data are presented on the longitudinal- and transverse-momentum spectra of π^- mesons produced in both π^-p and π^+p interactions at 18.5 GeV/c. These distributions are studied as a function of the number of charged particles observed in the final states. The spectra are discussed in terms of relevant models and are compared with similar data from pp interactions. The data cannot be factorized into a simple product of independent functions of longitudinal and transverse momentum. The distributions suggest strongly that a simple quark-quark model is inadequate to explain multipion production. (auth)

38672 OBSERVATION OF REACTION $\pi^-p \rightarrow e^+e^-n$ AT 275 MeV. Akimov, Yu. K.; Vertogradov, L. S.; Dem'yanov, A. V.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 4, 748-57(Apr 1971). (In Russian).

The reaction $\pi^- + p \rightarrow e^+e^-n$ was studied by means of an experimental set up consisting of scintillation and Čerenkov counters, total absorption Čerenkov spectrometers and spark chambers. Electrons and positrons were registered at angle close to 90° relative to π^--meson beam. Energy and emission angles of electrons and positrons were measured. The analysis of the data obtained made it possible to identify 55 events of this reaction with the effective mass of the pair e^+e^- about 300 MeV and to determine the differential cross section of the reaction above 40 MeV electron (positron) energy

$$\frac{d^2\sigma}{d\Omega_1 d\Omega_2} = (3.0 \pm 0.8)(10)^{-33} \text{ cm}^2/\text{sterad}^2. \text{ (auth)}$$

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38673 STUDY OF THE SYSTEMS $\pi^0\gamma$, $\eta^0\gamma$, $\pi^0\pi^0\gamma$, $\pi^0\pi^0$, IN REACTION $\pi^+ + p \rightarrow p + \pi^+ + m\gamma$ AT 2.9 GeV/c. Baldin, A. B.; Ergakov, V. A.; Trebukhovskii, Yu. V.; Shishov, N. N. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: No. 4, 758-64(Apr 1971). (In Russian).

The reaction $\pi^+ + p \rightarrow p + \pi^+ + m\gamma$ was studied using a 120 liter xenon-propane bubble chamber at 2.9 GeV/c. In the spectrum of the 3 quanta effective masses there was a maximum corresponding to the decay $\omega^0 \rightarrow \pi^0\gamma$. The ratio

$\frac{\omega^0 \rightarrow \pi^0\gamma}{\omega^0 \rightarrow \pi^+\pi^-\pi^0} = 0.081 \pm 0.020$ is estimated. The upper limits of the decay ratios

$\frac{\omega^0 \rightarrow \eta^0\gamma}{\omega^0 \rightarrow \pi^0\gamma} < 0.40$ and $\frac{\omega^0 \rightarrow \eta^0\pi^0\gamma}{\omega^0 \rightarrow \pi^0\gamma} < 0.14$ are measured with the 95% confidence. The distribution in the effective masses in the $2\pi^0$-meson system produced together with the isobar N^{*++} and in the missing masses in the π^+p system at $|t_{\pi^+\eta}| \leq 15\ \mu^2$, are given. The data obtained indicate the existence of a wide maximum in the mass region of the $\pi^0\pi^0$ system 500 MeV $\leq M_{\pi^0\pi^0} \leq$ 900 MeV. (auth)

38674 STUDY OF A_2 AND A_3 MESON PRODUCTION IN πp COLLISIONS AT 4.45 GeV/c. Beketov, G. V.; Zombkovskii, S. M.; Konovalov, B. S.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: No. 4, 765-71(Apr 1971). (In Russian).

The 3π-system mass spectrum is measured in the reaction $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ at 4.45 GeV/c. The cross sections of the A_2 and A_3-meson production are determined. The cross section of the A_2^--meson production was found to be 60 ± 7 mkb, the cross section of the A_3^- meson production with the decay $A_3^- \rightarrow \pi^+\pi^-\pi^-$ amounts to 90 ± 8 mkb, the cross section of the A_3-meson production with the decay $A_3 \rightarrow f^0\pi^-$ amounts to 63 ± 7 mkb. The distributions are constructed for the number of events of the reaction $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ in the value $t' = |t - t_{min}|$ for five intervals of the 3π system masses within 975 to 1975 MeV. These distributions were approximated by the exponent $d\sigma/dt' \sim \exp Bt'$. The values of the slope of B are determined. The quantum numbers of the A_2 meson are studied. The data obtained indicate the quantum numbers $J^P = 2^+$ both for nonsplit A_2 meson and for A_{2L} and A_{2H} mesons. (auth)

38675 ACCURATE MEASUREMENT OF THE BRANCHING RATIO $\eta \rightarrow$ NEUTRALS/$\eta \rightarrow$ TOTAL. Basile, M.; Bollini, D.; Dalpiaz, P.; (and others) (CERN, Geneva. Istituto Nazionale di Fisica Nucleare, Bologna. Centre National de Recherches Scientifiques, Strasbourg). Nuovo Cim.; 3A: No. 4, 796-806(21 Jun 1971).

The branching ratio $R = \Gamma(\eta \rightarrow \text{neutrals})/\Gamma(\eta \rightarrow \text{total})$ was measured with counter techniques. The η-mesons were produced in the reaction $\pi^- + p \rightarrow n + MM$ at 0.8 GeV/c. A total of ~24,000 η-events were observed. The value found is R = (70.5 ± 0.8)%. The 90% confidence level for the branching ratio $R' = \Gamma(\eta \rightarrow \pi^0\gamma\gamma)/\Gamma(\eta \rightarrow \text{total})$ is found to be $R' \leq 10\%$. (auth)

38676 π^-–^{4}He COHERENT SCATTERING AT 1.25 GeV/c. Combe, J. (Nuclear Physics Lab., Clermont-Ferrand, France); Gardes, J.; Querrou, M.; Dahl-Jensen, E.; Doble, N. Nuovo Cim.; 3A: No. 4, 663-9(21 Jun 1971).

The differential elastic-scattering cross section of π^- on ^{4}He is given at 1.25 GeV/c. The recoil ^{4}He coming from a gas target is detected by nuclear emulsions in a momentum-transfer region between 0.15 and 0.5 $(GeV/c)^2$. (auth)

38677 COHERENT SCATTERING OF π^-–^{4}He AT 1.12 GeV AND DETERMINATION OF THE PARTIAL-WAVE AMPLITUDE OF π-NUCLEON SCATTERING. Querrou, M. (Faculte des Sciences, Clermont-Ferrand, France). Nuovo Cim.; 3A: No. 4, 670-9(21 Jun 1971). (In French).

Recent experimental results about π^-–^{4}He coherent elastic cross section at 1.12 GeV are compared with the data of Palevsky et al., (p-^{4}He) and Frosch et al. (e-^{4}He). These results are in agreement if one uses the Glauber multiple-scattering theory. They permit to discriminate between π-nucleon phase-shift amplitudes of different groups which give very different values of the real part of the amplitude. The experimental cross section in the double-scattering region is in a rather good agreement with the phase shift of Saclay. More extensive calculations including Fermi momentum distribution of nucleons do not modify this conclusion. (auth)

38678 $\pi B \rightarrow B\rho\pi$ REACTION IN π^+d INTERACTION AT 5.1 GeV/c. Murro, O.; Picciarelli, V. (Univ., Bari, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy). Nuovo Cim.; 3A: No. 4, 721-46(21 Jun 1971).

The reaction $\pi B \rightarrow B\rho\pi$ is studied in the π^+d interactions at 5.1 GeV/c. The mass spectra are investigated, especially in the region $m(\rho\pi) < 1.2$ GeV. An analysis is also made to investigate the production mechanisms which contribute to the final state. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 38629, 38791, and 39091.

38679 (NP-18757) KINEMATICS OF MULTIPARTICLE FINAL STATES AND DIFFERENT WAYS OF PRESENTING DATA ON MULTIPARTICLE FINAL STATES. Nyborg, Per (Agricultural Coll. of Norway, Vollebekk. Dept. of Mathematics). Apr 1970. 100p. Dep. NTIS (U. S. Sales Only).

A systematic presentation is given of kinematics and phase space for n-particle final states in terms of 2n-3 invariants and n-1 angles. It is shown how to establish descriptions to suit any decay scheme for a n-particle final state. Data presentation is discussed. From the complete 3n-4 dimensional descriptions of phase space, the physical boundaries and the phase space density in various scatterplots (two-dimensional projections) are obtained by integration. A survey of scatterplots corresponding to the various complete descriptions of phase space should be of considerable interest. One should then be able to decide which scatterplots to use when presenting data, and also how to extract, from the experimental distribution of events, information on the dynamics of the process studied. Six different scatterplots in invariant variables are described for the three-particle final state, plots involving (M_{12}^2, M_{23}^2), (T_{b1}^2, M_{23}^2), (T_{b1}^2, M_{12}^2), (T_{b1}^2, T_{a3}^2), (T_{b1}^2, T_{a1}^2), and (T_{a1}^2, T_{a3}^2), respectively. For n-particle final states, the various scatterplots involving two invariant masses are considered together with the $(T_{b1\ldots k}^2, M_{(k+1)\ldots n}^2)$-plots. Longitudinal momentum plots are also included in the survey of scatterplots. (auth)

38680 (UCR-34-P-107-B-124) ANNUAL REPORT. Kerman, A.; Poe, R. T. (California Univ., Riverside). May 1971. Contract AT(04-3)-34. 23p. Dep. NTIS.

Both experimental and theoretical research on high-energy physics is summarized. A list of publications issued during the period is included. (J.F.P.)

38681 RECENT DEVELOPMENTS IN PARTICLE PHYSICS. Alvarez, L. W. (Univ. of California, Berkeley). pp 1-49 of Evolution of Particle Physics. /Conversi, M. (ed.). New York- Academic Press Inc. (1970). (1970).

A historical review is given of recent progress in particle physics. This review includes strange and resonance particle discoveries and the development of the bubble chamber. (J.F.P.)

38682 OLD PROBLEMS AND NEW IDEAS IN ELEMENTARY PARTICLE PHYSICS. Fubini, S. (Univ., Turin). pp 133-7 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

A brief survey of progress toward a satisfactory theory accounting for the different phenomena in elementary particle physics is given. Crossing relations and duality are discussed. It is concluded that the duality approach might be the first step toward such a theory. (J.F.P.)

38683 SEARCH FOR NEW STABLE PARTICLES. Pontecorvo, B. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 210-17 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

A method is proposed for the search for neutral and charged stable particles by studying their radioactivity properties. (J.F.P.)

38684 AMATEUR'S VIEW OF PARTICLE PHYSICS. Weisskopf, V. F. (Massachusetts Inst. of Tech., Cambridge). pp 273-86 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

A discussion of particle physics is given and includes the spectroscopy of hadrons, electron scattering, current algebra, strong interaction processes, and CP violation. (J.F.P.)

38685 RADIATIVE CORRECTIONS TO LOW-ENERGY THEOREMS. Cheng, Ta-pei. New York; Rockefeller Univ. (1969). 99p. University Microfilms Order No. 71-9492.
Thesis.

A general method is presented for evaluating, in a model-independent way, the soft virtual photon radiative corrections to an arbitrary hadronic process. It is shown that all the results concerning infrared divergences obtained within the theory of quantum electrodynamics of the electron–photon system are, in fact, exact in strong interactions. The problem of radiative corrections to low-energy theorems is the primary concern of this investigation. The threshold contributions of intermediate soft photon states are nonanalytic in the photon-frequency (ω). While the procedure is general enough to permit, in principle, the calculation of the leading terms (as $\omega \to 0$) of these radiative corrections to all orders in e, only the leading e^2 radiative corrections are computed explicitly: they are of the order $\ln \omega$ for the bremsstrahlung, of the order $\omega \ln \omega$ for pion-photo-production. Accordingly, in the presence of radiative corrections, there are no longer any low-energy theorems for the $O(\omega^0)$ bremsstrahlung and $O(\omega)$ pion-photo-production amplitudes. The e^4 Compton amplitude $O(\omega^2 \ln \omega)$ is computed and shown to be independent of the target spin. A review of the usual low-energy theorems, which have been proven to the lowest order in e, is also presented. (Diss. Abstr. Int., B)

38686 CORRELATION RELATIONS BETWEEN THE PAIRS OF SECONDARY PARTICLES IN PROCESSES OF MULTIPLE GENERATION AT $0.5(10)^{12}$ eV. Berdzenishvili, O. L.; Gabuniya, L. L.; Garibashvili, D. I.; (and others) (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 13: No. 4, 779-85(Apr 1971). (In Russian).

Correlations between the pairs of secondary particles in processes of multiple generation at $0.5(10)^{12}$ eV are studied. To this end the method of artificial alignment of particles according to the momentum increase and study of the pairs closest in the momentum is used. The experimentally observed spectrum p_i/p_{i+1} where p_i and p_{i+1} are the momenta of two neighboring pairs after the alignment reveals a considerable difference from that for non-correlated pairs. Investigation of the sum of transversal momenta of the pairs of neighboring particles indicates the absence of correlations. (auth)

38687 GENERATION OF SUPER HIGH ENERGY COSMIC RAYS. Berezinskii, V. S.; Zatsepin, G. T. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 13: No. 4, 797-803(Apr 1971). (In Russian).

In view of the recent experimental data, various assumptions are discussed which were made to explain the absence of a cut-off in the cosmic ray spectrum at $(2 \text{ to } 8) \cdot 10^{19}$ eV. Energy losses of the nuclei by the relic radiation and light are calculated. (auth)

38688 FURTHER DEVELOPMENT OF THE INTRANUCLEAR CASCADE MODEL. Barashenkov, V. S.; Il'inov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 4, 743-7(Apr 1971). (In Russian).

A model is proposed which takes into account the local variation of density of the nuclear matter as the cascade shower develops. The calculation results are in good agreement with the experiment up to $T \approx 30$ GeV. The contribution from various interactions within all this region appears to be unessential. (auth)

Electromagnetic

Refer also to abstracts 38774 and 38833.

38689 (DESY-71/19) PRELIMINARY RESULTS ON COINCIDENCE MEASUREMENTS FOR ELECTROPRODUCTION IN THE DEEP INELASTIC REGION. Brasse, F. W.; Fehrenbach, W.; Flauger, W.; Frank, K. H.; Gayler, J.; Korbel, V.; May, J.; Zimmerman, P. D.; Ganssauge, E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr 1971. 13p. Dep. NTIS (U. S. Sales Only).

In the deep inelastic region of electroproduction coincidence measurements for the reactions $e + p \to e + p + M_x$ and $e + p \to e + \pi^+ + M_y$ were made. Preliminary results for the production cross sections by virtual photons $d^2\sigma/d\Omega dP_{p,\pi}$ and $d^2\sigma/d\Omega dM_{x,y}$ are given. (auth)

38690 HIGH ENERGY e^+-e^- ANNIHILATION INTO HADRONS. Gatto, R. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). pp 138-47 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

The relation of $e^+ - e^-$ cross sections to hadronic contributions to vacuum polarization and the possible asymptotic behaviors of the cross section are considered in order to provide a classification of cross section behaviors and related sum rules and to illustrate the possible underlying physical interpretation. (J.F.P.)

38691 CLASSICAL ELECTRON, A MODEL FOR AN EXTENDED CHARGED PARTICLE. Horwitz, G.; Katz, J. (Hebrew Univ., Jerusalem). Nuovo Cim., 3B: No. 2, 245-61(11 Jun 1971).

A classical model of the extended electron was worked out. An electron is regarded as an extended spherical charge stabilized by Poincaré stresses arising in a medium. In addition to the electrostatic energy of the region inside the charge, the stress energy of the medium is included. This choice is justified and leads to a solution for which the electron mass is $\frac{4}{3}m_e$, $m_e c^2$ being the total electrostatic energy. In addition to the determination of the radius and the distribution of the rest energy between the inside and outside of the charge, the theory also predicts charge and charged-mass distributions for the model. (auth)

38692 FORCES ACTING ON MAGNETIC DIPOLES. Hrasko, P. (Central Research Inst. for Physics, Budapest). Nuovo Cim., 3B: No. 2, 213-24(11 Jun 1971).

An attempt is made to derive the forces acting on a point-like magnetic dipole by a structure-independent method. The force expression thus obtained is different from the Lorentz force applied to an Amperian current loop, as first pointed out by Shockley and James. An expression is obtained for the force acting on a neutral Dirac particle with an anomalous magnetic moment. The relativistic equations of motion are formulated, and the solutions in a homogeneous magnetic field are discussed. It is concluded that the dipoles are accelerated along the field. (auth)

38693 GAUGE INVARIANCE, KINEMATICAL SINGULARITIES, AND ELECTRO- AND PHOTOPION PRODUCTION AMPLITUDES. Dubec, M. (Comenius Univ., Bratislava). Czech. J. Phys.; 21: No. 6, 623-35(1971).

The kinematical singularities connected with the gauge invariance are considered and the conventional sets of invariant amplitudes discussed. A new set of invariant amplitudes for electroproduction of pions on nucleons is proposed, which contains the transversal subset of photoproduction amplitudes, is free of kinematical singularities, and more convenient for practical calculations. (auth)

38694 SIMILARITY HYPOTHESIS IN STRONG INTERACTIONS. II. CASCADE FORMATION OF HADRONS AND THEIR ENERGY DISTRIBUTION IN e^+e^- ANNIHILATION. Polyakov, A. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 5, 1572-83(May 1971). (In Russian).

The energy distribution of hadrons in e^+e^- annihilation is studied on the basis of the similarity hypothesis. The result is not consistent with the Bjørken formula employed previously. It is found that the similarity law is valid only for energy distribution moments. A qualitative description corresponding to the similarity hypothesis is proposed. The problem of self-consistency of the hypothesis is discussed. (auth)

38695 K_{l3}-DECAY FORM FACTORS AND ASYMPTOTIC SU(3) SYMMETRY. Oneda, S.; Yabuki, H. (Univ. of Maryland, College Park). Phys. Rev., D; 3: No. 11, 2743-51(1 Jun 1971).

A relation between the K_{l3}-decay form factors and the pion electromagnetic form factor is derived by using only the hypothesis of asymptotic SU(3) symmetry. This relation allows the complete behavior of the K_{l3}-decay form factors to be predicted, once the behavior of the pion electromagnetic form factor is given. For the choice of the dipole formula, $(1 - t^2/m_\rho^2)^{-2}$, for the pion form factor, the following parameters of the K_{l3}-decay form factors predicted: $\xi(0) \simeq -0.53$, $\lambda_+ \simeq 0.023$, and $\lambda_- \simeq 0.0010$. If the result from the physical K_{l3}-decay region $0 \le t \le (m_K - m_\pi)^2$ is extrapolated to include the region $0 \le t \le (m_K + m_\pi)^2$, the presence of a dip in the K_{l3}-decay scalar form factor in this region is indicated. The extrapolated form factor satisfies approximately the soft-pion constraint given at $t = m_K^2$. The effect of particle mixing between the usual pseudoscalar nonet and the possible higher-lying pseudoscalar mesons is not considered. (auth)

38696 REMARK ON THE ISOSPIN MASS DIFFERENCES. Johnson, Joseph E. (Univ. of South Carolina, Columbia). Phys. Rev., D; 3: No. 11, 2648-51(1 Jun 1971).

The isospin splittings of the $\frac{1}{2}^+$ baryon octet are observed empirically to depend upon the (average) sum of charge and hypercharge or equivalently, upon the (average) $V_3 = -\frac{1}{2}(Q + Y)$ spin component. A simple quark model compatible with this observation is constructed and then this model is used to predict the $\frac{3}{2}^+$ decuplet isospin splittings. One obtains different decuplet predictions from the standard approach, enabling one eventually to

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test whether or not the baryon regularity is accidental. If nonaccidental, then support is given to recent conjectures that isospin splittings may be partially nonelectromagnetic. (auth)

38697 TRANSITION RADIATION FROM MAGNETIC MONOPOLES. Dooher, John (Grumman Aerospace Corp., Bethpage, N. Y.). Phys. Rev., D; 3: No. 11, 2652-60(1 Jun 1971).

Transition radiation from Dirac magnetic monopoles is calculated. The image picture is applied and compared with the rigorous solution of Maxwell's equations utilizing the symmetry between magnetic and electronic charges. Possible experimental applications are discussed in searching for monopoles in accelerators and cosmic radiation. (auth)

38698 HIGH-ENERGY PHOTOPRODUCTION OF NONRESONANT $\pi^+\pi^-$ PAIRS AND THE DIPION FINAL-STATE INTERACTION. Bauer, Theodore (Daresbury Nuclear Physics Lab., Eng. Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 3: No. 11, 2671-85(1 Jun 1971).

Working with nuclei as targets, a theory is presented for the high-energy photoproduction of nonresonant $\pi^+\pi^-$ pairs which takes into account the scattering of both pions from the nucleus. Our amplitudes turn out to be significantly smaller than those calculated using the conventional Drell–Söding theory of this process, which allows for the scattering of only one pion. The fact that these pion pairs can resonate in the final state and form a ρ^0 meson "anomalously" is taken into account. Both of these effects are relevant to the analysis of the reaction $\gamma + A \rightarrow \pi^+ + \pi^- + A$ and "anomalous" ρ^0 photoproduction should prove relevant, as well, to understanding the reaction $\gamma + A \rightarrow l^+ + l^- + A$. (auth)

38699 PION ELECTROPRODUCTION, ρ PRODUCTION BY PIONS, AND VECTOR-MESON DOMINANCE. Manweiler, R. W. (Cornell Univ., Ithaca, N. Y.); Schmidt, W. Phys. Rev., D; 3: No. 11, 2752-67(1 Jun 1971).

A unified account for the isovector contribution to ρ production, pion photoproduction, and electroproduction in the near-forward direction of the pion is given, and its relationship to vector-meson dominance is discussed. The high-energy limit is discussed in detail, first for the electric Born model, and then for a more realistic model derived from fixed-t dispersion relations. Very simple features emerge, which in most cases can also be observed at low energies. Numerical results of our model are given for all three types of reactions. (auth)

38700 PHENOMENOLOGICAL ANALYSIS FOR THE ELECTROMAGNETIC FORM FACTOR OF THE PION. Liu, Yu-chien; McGee, Ian J. (Univ. of Waterloo, Ont.). Phys. Rev., D; 3: No. 11, 2906-9(1 Jun 1971).

Using the results from electron–positron colliding-beam experiments, a phenomenological analysis was made by means of the continuous-dispersion sum rules for the pion electromagnetic form factor. Results such as $\Gamma_\rho = 0.110$ GeV, $a_1(\pi\pi) = 0.028\mu^{-2}$, $|F_\pi(m_\rho^2)|^2 = 48.8$, $r_\pi = 0.62$ F, $\delta\mu$ (the pion mass difference) = 4.3 MeV were obtained, and sum rules involving amplitudes accessible to $e^+e^- \rightarrow \pi^+\pi^-$ and $\pi e \rightarrow \pi e$ processes tested. (auth)

38701 MODEL FOR VECTOR–MESON PHOTOPRODUCTION AT HIGH ENERGY. Fuchs, Norman H. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 3: No. 11, 2786-95(1 Jun 1971).

A model for high-energy vector-meson photoproduction is described in which the incident photon dissociates into a charged pion or kaon pair, one of the virtual mesons scatters, and then the pair combines to form a vector meson. The amplitudes constructed have several theoretically desirable characteristics, such as (i) analyticity and correct singularity structure in the mass squared for the photon, and (ii) approximate unitarity in the crossed channel. Agreement with present high-energy experimental data is good in that s-channel helicity conservation is obtained and differential cross sections have the correct shape; however, some results, notably the energy dependence, appear to be in disagreement with experiments. (auth)

38702 TEST OF QUANTUM ELECTRODYNAMICS BY ELECTRON–ELECTRON SCATTERING. Barber, W. C. (Stanford Univ., Calif.); O'Neill, G. K.; Gittelman, B.; Richter, B. Phys. Rev., D; 3: No. 11, 2796-2800(1 Jun 1971).

The differential cross section for electron–electron scattering was measured at a total energy of 1112 MeV in the center-of-mass system. Using the Feynman regulator as a model for violation, with K a cutoff momentum, $K^{-2} = 0.044 \pm 0.049$ (GeV/c)$^{-2}$ was found. The error quoted represents a statistical contribution of ±0.042 combined in quadrature with ±0.025 representing the uncertainty of possible systematic contributions. This result is one of the most sensitive high-momentum-transfer tests of the photon propagator in quantum electrodynamics. (auth)

38703 IS THERE A VECTOR-DOMINANCE FRAME PROBLEM? Mannheim, Philip D. (Univ. Libre, Brussels). Phys. Rev., D; 3: No. 11, 2840-7(1 Jun 1971).

It is argued that it is not meaningful to discuss the vector-dominance model using the language of longitudinal projections. It is found that a more suitable language for vector dominance is in terms of electric and magnetic couplings rather than in terms of longitudinal and transverse ones. The use of only the off-shell invariant amplitudes ("Ball amplitudes") is advocated. The experimental failure of the model for polarized photoproduction of pions then implies either that some of the Ball amplitudes require subtractions in k^2, the mass of the current, or that states other than ρ, ω, and φ also couple to the electromagnetic current. (auth)

38704 REGGE MODEL WITH SCALE-INVARIANCE FOR NUCLEON COMPTON SCATTERING, ELECTROPRODUCTION, AND ELECTRON–POSITRON ANNIHILATION. Moffat, J. W.; Snell, V. G. (Univ. of Toronto). Phys. Rev., D; 3: No. 11, 2848-61(1 Jun 1971).

A Regge model satisfying the requirement of scale invariance is constructed for the Compton amplitude. Using the P, P′, and A_2 Regge trajectories, good fits are obtained to the total photon–nucleon cross sections and to the differential cross section $d\sigma/dt$ for proton Compton scattering. The model is then applied to electroproduction in the deep-inelastic region and successfully describes the data on the proton and neutron structure functions, the breaking of scale invariance at small $-q^2$ and the behavior of the ratio W_2^n/W_2^p, as a function of $-q^2$ for fixed hadronic mass squared. Predictions are given for the differential cross section for the crossed-channel process $e^+ + e^- \rightarrow$ proton + hadrons, and it is found that for large q^2 the total annihilation cross section behaves as $\sigma_T \approx 1/q^2$. (auth)

38705 SOME QUARK–PARTON-MODEL INEQUALITIES FOR THE NEUTRON AND PROTON INELASTIC STRUCTURE FUNCTIONS. Majumdar, D. P. (Syracuse Univ., N. Y.). Phys. Rev., D; 3: No. 11, 2869-74(1 Jun 1971).

Several inequalities for the neutron and proton inelastic structure functions $W_2(\psi,Q^2)$ that must be satisfied if the partons are identified with quarks are summarized. Some of these inequalities provide very useful constraint equations for the P(N) function of the parton model. Due to lack of sufficient data, it is not certain at present if all the inequalities are satisfied. The importance of these inequalities lies in the fact that if any of them are confirmed not to satisfy the experimental data, the concept of individual quark-parton association has to be abandoned. (auth)

38706 ASYMPTOTICS OF TOTAL ANNIHILATION CROSS SECTION OF e^+e^- PAIR INTO ANY NUMBER OF PHOTONS AND ANY NUMBER OF $\mu^+\mu^-$ PAIRS AT HIGH ENERGY. Kuraev, E. A.; Nesterov, M. M.; Ol'shanskii, Yu. E. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 13: No. 4, 825-31(Apr 1971). (In Russian).

Asymptotics of e^+e^--pair annihilation cross section into any number of $\mu^+\mu^-$ pairs with emission of any number of photons is calculated. It is shown that summing up the cross sections with various numbers of the muon pairs one gets a parameter that is not the double logarithm: $\alpha^5/_4 \ln^3/_{25}$. (auth)

38707 PION ELECTROMAGNETIC FORM FACTOR AND DISPERSION RELATIONS. Shcherbin, Yu. P. (Leningrad State Univ.). Yadern. Fiz.; 13: No. 4, 832-9(Apr 1971). (In Russian).

In the framework of the conventional assumptions on the analytic properties of the pion form factor, dispersion relations and dispersion sum rules are considered that relate the values of the form factor at the space-like and time-like momentum transfers. The relations are suitable to analyze the available present experimental data on the pion form factor. The contribution to the dispersion relations from various complex zeroes is investigated, and numerical calculations are carried out for some of the relations. (auth)

38708 SUM RULES FOR THE γ SCATTERING AMPLITUDES AND ANTIBOUND STATE OF TWO π MESONS WITH $J = 2$, $I = 0$. Fil'kov, L. V. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 13: No. 4, 840-4(Apr 1971). (In Russian).

Dispersion sum rules relating the coupling constants of 2^+ mesons with the integral of quadratic functions of the photoproduction amplitudes are constructed on the basis of linear dependence between the γp scattering amplitudes at $\theta = 180°$. In order to obtain the signs of the coupling constants of f meson with nucleon, which are in agreement with the results of previous work the sum rules take into account the antibound state of a system of two π mesons with $J = 2$ and $I = 0$. (auth)

38709 SUM RULES AND FIELD ALGEBRAS. Lazarenko, L. A.; Soroka, V. A. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: No. 4, 845-50(Apr 1971). (In Russian).

Sum rules are obtained for the Compton scattering on pions and nucleons that are consequences from commutation relations for the components of the electromagnetic current and its time derivative. The matrix element $\langle p|j_i(0)j_k(0)|p\rangle$ (where $j_i(0)$ is the electromagnetic current) is related to the observable quantities—form factors of the elastic and inelastic electron scattering. Convergence of the sum rules is possible if a number of asymptotical relations are valid for the elastic and inelastic form factors. (auth)

38710 HOW TO CATCH A PHOTON AND MEASURE ITS MASS. Goldhaber, Alfred S. (CERN, Geneva). Phys. Rev. Lett.; 26: No. 22, 1390-2(31 May 1971).

The physical significance of a class of "table-top" experiments proposed by Franken and Ampulski as tests for a finite photon mass μ is examined. The results stem from a theorem that in the massive-photon case the fields and currents of a system are changed only by order $(\mu D)^2$ from those of the massless-photon case (D is the dimension of the system). This implies that the table-top method is only weakly sensitive to small "Yukawa" deviations from Coulomb's law, and so the theorem constitutes a rebuttal to the suggestion that the method can improve present limits on the photon mass. Instead it appears that Franken and Ampulski have devised a sensitive test of Faraday's Law. (auth)

38711 COMMENTS ON A PROPOSAL FOR DETERMINING THE PHOTON MASS. Park, David; Williams, E. R. (Williams College, Williamstown, Mass.). Phys. Rev. Lett.; 26: No. 22, 1393-4(31 May 1971).

It has recently been proposed that it may be possible to establish a new upper limit on the photon mass by means of measurements on an oscillating circuit with a frequency about 1 rad/sec. It is shown that the argument is in error, and that in reducing the size of their apparatus from the photon's conjectured Compton wavelength to table-top size the sensitivity of their experiment was lowered by the same ratio. (auth)

38712 THEORETICAL INTERPRETATION OF A RECENT EXPERIMENTAL INVESTIGATION OF THE PHOTON REST MASS. Kroll, Norman M. (Stanford Univ., Calif.). Phys. Rev. Lett.; 26: No. 22, 1395-8(31 May 1971).

It is shown that both small-dimensional, extremely low-frequency resonant circuits and long coaxial cables are unsuited to the setting of significant limits on the photon rest mass. (auth)

Weak

38713 DETERMINATION OF THE AXIAL-VECTOR COUPLING FOR STRANGENESS NONCHANGING CURRENTS. Franzinetti, C. (Univ., Turin); Stoppini, G. pp 114-32 of Evolution of Particle Physics. /Conversi, M. (ed.). New York ; Academic Press Inc. (1970).

The discussion of the determination of the axial-vector coupling for strangeness nonchanging currents covers the determination of G_A in experiments at low momentum transfer, the physical interpretation of the experimental result $G_A/G_V = 1.18$, and the q^2 dependence of the axial-vector coupling. (J.F.P.)

38714 RANGE AND STRAGGLING OF MUONS. Wilson, R. R. (National Accelerator Lab., Batavia, Ill.). pp 294-8 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

The range of muons is calculated including radiation, pair production, and nuclear effects. It is shown that the large individual energy losses characteristic of these processes reduce the average range by a factor of ln2 from that which one would get on the basis of simply integrating the average energy loss. The fractional straggling first increases as radiation and pair production effects become important and then decreases as the energy is further increased. (auth)

38715 INTERMEDIATE VECTOR BOSON. Commins, Eugene (Univ. of California, Berkeley). New Sci. Sci. J.; 50: No. 751, 382-4(13 May 1971).

The intermediate vector boson (W) qualifies as one of the elusive particles of high energy physics. Yet the reasons for its existence are so compelling that theorists and experimenters have not lost hope of observing it after 14 years of fruitless searches. (auth) (UK)

38716 EFFECT OF OCTET MASS BREAKING ON K_{l3} FOR FACTORS. Rest, J.; Welling, D. J. (Univ. of Wisconsin, Milwaukee). Phys. Rev., D; 3: No. 11, 2783-5(1 Jun 1971).

Octet breaking in SU_3 is used together with a "weighted" linear transformation for the physical fields to determine the effect of symmetry breaking by mass splitting on the K_{l3} form factors. It is argued that the "weighted" linear transformation at small three-momentum is a reliable approximation to the nonlinear transformation nature of the physical fields. A result for ξ, consistent with this approximation and the Gell-Mann–Okubo mass formula, is obtained and provides $\xi = -0.86$. (auth)

38717 $\Delta I = \frac{1}{2}$ RULE WITH FERMION QUARKS. Pati, J. C.; Woo, C. H. (Univ. of Maryland, College Park). Phys. Rev., D; 3: No. 11, 2920-2(1 Jun 1971).

It is shown that the Fierz reshuffling symmetry of the V – A interaction combined with current algebra and partial conservation of axial-vector current provides a reasonable explanation for the $\Delta I = \frac{1}{2}$ rule in the framework of the three-triplet model with fermion quarks. This explanation can be distinguished from that based on an ad hoc boson quark assumption by studying whether the parity-violating $\Delta Y = 0$ nuclear transitions contain a significant $\Delta I = 2$ part. (auth)

38718 EXACT SUM RULE FOR TRANSITION AMPLITUDES AND $K_L - K_S$ DECAY. Kerler, W. (Univ., Marburg, Ger.). Phys. Rev., D; 3: No. 11, 2909-12(1 Jun 1971).

It is pointed out that there is just one exact form of the sum rule holding for specific transition amplitudes. The assumptions and approximations implicit in the various usual formulations are analyzed on the basis of this result. The adequate description of the time dependence is discussed. (auth)

38719 EXACT BOUNDS FOR K_{l3} DECAY PARAMETERS. Okubo, Susumu (Univ. of Rochester, N. Y.). Phys. Rev., D; 3: No. 11, 2807-13(1 Jun 1971).

Exact bounds are derived for the K_{l3} decay form factors $f_i(t)$. Particularly, the bound $(m_K^2 - m_\pi^2)|f_+(0)| \leq 16[\frac{1}{2}\pi\Delta(0)]^{\frac{1}{2}}(m_K + m_\pi)^{\frac{1}{2}}(m_K^{\frac{1}{2}} + m_\pi^{\frac{1}{2}})^{-1}$ is obtained where $\Delta(0)$ is the propagator of the divergence of the strangeness-changing current at zero momentum. If the Hamiltonian of Gell-Mann, Oakes, and Renner is assumed in order to estimate $\Delta(0)$, $|f_+(0)| \lesssim 1.0$ is obtained. Similarly, an inequality testing the standard K_{l3} soft-pion theorem is found to be well satisfied. In addition, a new inequality involving derivatives of $f_+(t)$ is derived. Taking $\lambda_+ \sim 0.02$, this inequality leads to $|f_-(0)| \lesssim 0.33$. (auth)

38720 OKUBO'S SECOND-CLASS CURRENTS IN K_{l2} AND K_{l3} DECAYS. Kang, Kyungsik; Olshansky, Robert (Brown Univ., Providence). Phys. Rev., D; 3: No. 11, 2894-7(1 Jun 1971).

The modification of the weak-interaction theory recently proposed by Okubo is compared with the current-current weak-interaction theory generalized to include local scalar or tensor interactions for K_{l2} and K_{l3} decays. In contrast to the latter, the existence of Okubo's tensor or scalar densities is difficult to verify from K_{l2} and K_{l3} experiments unless one has a reliable theoretical model for the pure V – A vertices. In particular, various possible explanations for the K_{l3} parameters are discussed. (auth)

38721 COMMENTS ON HADRONIC HELICITY CONSERVATION IN INELASTIC LEPTON–NUCLEON REACTIONS. Elitzur, M.; Pais, A. (Rockefeller Univ., New York). Phys. Rev., D; 3: No. 11, 2897-9(1 Jun 1971).

If and where inelastic lepton–nucleon reactions satisfy hadronic helicity conservation in an arbitrary hadronic frame, isotropy is shown to follow with respect to an azimuthal angle, properly defined. For all instances other than s-channel helicity conservation, another dynamical variable must be made to vary in order to observe this azimuthal independence at a given incoming laboratory energy of the leptons. The discrimination between different hadronic frames with regard to possible helicity conservation demands some care, since such conservation can lead to approximately the same isotropy effect in certain specified kinematic regions. (auth)

38722 KINEMATICAL DISTRIBUTIONS OF NEUTRINO-PRODUCED LEPTON TRIPLETS. Loevseth, Joergen; Radomski, Mark (Stanford Univ., Calif.). Phys. Rev., D; 3: No. 11, 2686-2706(1 Jun 1971).

Differential distributions in lepton triplets $\nu_\mu\mu^-\mu^+$, $\nu_e\mu^-e^+$, $\nu_e e^-e^+$ produced from neutrinos through the point four-fermion interaction and single-photon exchange with a nuclear target were calculated using a Monte Carlo method. These are fundamental processes which can be calculated to arbitrary accuracy, and which test aspects of the leptonic weak interactions, in particular diagonal processes, which are not accessible to other tests. The calculations cover energies from 1.5 to 40 GeV, and targets

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of mass 1, 12, 56, and 208. Salient features of the results are *that typically the negative lepton is energetic, the positive one* much less energetic, and transverse momenta of the charged leptons are quite large (100–200 MeV/c at 15 GeV). (auth)

38723 CROSS SECTION OF REACTION $\nu_e + Z \rightarrow Z + e^- + \pi^+$ Berezinskii, V. S.; Grigor'eva, S. I. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 13: No. 4, 817-19(Apr 1971). (In Russian).

The cross section of reaction $\nu_e + Z \rightarrow Z + e^- + \pi^+$ is expressed in terms of the form factors of $\pi^0 \rightarrow 2\gamma$ decay of the axial variant of $\pi \rightarrow e\nu\gamma$ decay and in terms of the parameter determining the dependence of form factor on the momentum transfer. The cross section was found to be by 4 orders of magnitude larger than that for pointlike pion. (auth)

Strong (General)

38724 (CERN–71-12) THERMODYNAMICS OF STRONG INTERACTIONS. Lectures Given in the Academic Training Programme of CERN, 1970–1971. Hagedorn, R. (European Organization for Nuclear Research, Geneva (Switzerland)). 7 May 1971. 137p. Dep. NTIS (U. S. Sales Only).

The lectures on the thermodynamics of strong interactions cover the separation of kinematics and thermodynamics, the main principles of statistical thermodynamics, motivation of the particular structure of hadron thermodynamics, the partition function and the solution of the bootstrap condition, and the bootstrap solution. Also discussed are the derivation of distributions from Z(V,T), physical properties of a fireball, and conservation laws. Applications are made to collision processes and astrophysics. (J.F.P.)

38725 EXOTIC MESONS AND THE HADRONIC ENERGY MOMENTUM TENSOR. Freund, P. G. O. (Imperial Coll. of Science and Tech., London. Univ. of Chicago). Contract AT(11-1)-264. Phys. Lett.; 35B: No. 4, 317-20(7 Jun 1971).

It is argued that SU(3)-singlet exotic (i.e. built of two or more quark–antiquark pairs) tensor mesons make large contributions to matrix elements of the energy-momentum tensor. An apparent inconsistency between meson dominance models and exchange degeneracy is thereby removed. New predictions about exotic meson couplings follow. (auth)

38726 TRIPLE POMERON VERTEX, DUALITY, AND DIFFRACTION DISSOCIATION. Ting, P. D.; Yesian, H. J. (Univ. of California, San Diego, La Jolla). Phys. Lett.; 35B: No. 4, 321-4(7 Jun 1971).

By invoking duality for the Reggeon-particle absorptive part, the triple Reggeon coupling is related to the low missing mass spectrum in diffraction dissociation. Existing experimental data are analyzed and suggest that the triple Pomeron coupling is small. (auth)

38727 CURRENT MATRIX ELEMENTS FROM A RELATIVISTIC QUARK MODEL. Feynman, R. P.; Kislinger, M.; Ravndal, F. (California Inst. of Tech., Pasadena). Phys. Rev., D; 3: No. 11, 2706-32(1 Jun 1971).

A relativistic equation to represent the symmetric quark model of hadrons with harmonic interaction is used to define and calculate matrix elements of vector and axial-vector currents. Elements between states with large mass differences are too big compared to experiment, so a factor whose functional form involves one arbitrary constant is introduced to compensate this. The vector elements are compared with experiments on photoelectric meson production, K_{l3} decay, and $\omega \rightarrow \pi\gamma$. Pseudoscalar-meson decay widths of hadrons are calculated supposing the amplitude is proportional (with one new scale constant) to the divergence of the axial-vector current matrix elements. Starting only from these two constants, the slope of the Regge trajectories, and the masses of the particles, 75 matrix elements are calculated, of which more than $^3/_4$ agree with the experimental values within 40%. The problems of extending this calculational scheme to a viable physical theory are discussed. (auth)

38728 SOME CONSEQUENCES OF TENSOR-MESON DOMINANCE. Raman, K. (Wesleyan Univ., Middletown, Conn.). Phys. Rev., D; 3: No. 11, 2900-6(1 Jun 1971).

Different versions of tensor-meson dominance (TMD) are discussed. Evidence is presented for the need for subtraction terms in the TMD relations in order to remove certain discrepancies in the predictions of tensor-meson pole dominance. Sum rules for coupling constants and results for meson and baryon mass form factors are obtained. Methods of incorporating symmetry breaking are discussed. (auth)

38729 PARTON MODEL AND INELASTIC PROCESSES WITH TWO PHOTONS. Brodsky, Stanley J. (Stanford Linear Accelerator Center, Calif.); Roy, Probir. Phys. Rev., D; 3: No. 11, 2914-20(1 Jun 1971).

It is proposed that highly inelastic hadronic reactions involving two photons (Compton scattering, photoproduction of low-mass μ pairs, hadron-hadron γ-pair production, etc.) be studied to distinguish between two approaches to the parton model: the direct impulse approximation of Bjorken and Paschos, and the field-theoretic method of Drell, Levy, and Yan. Such a distinction may be possible since a field-theoretic justification of the free-parton approximation in such processes cannot be given except in a limited kinematic region. (auth)

38730 STATISTICAL BOOTSTRAP MODEL OF HADRONS. Frautschi, Steven (California Inst. of Tech., Pasadena). Phys. Rev., D; 3: No. 11, 2821-34(1 Jun 1971).

The hadron is considered to be a compound with two or more constituents circulating freely in a box of radius $\approx 10^{-13}$ cm. The density of hadron levels, $\rho(m)$, is estimated from the number of states in the box (statistical condition) and is also required to be consistent with the spectrum of constituents, which are assumed to be the hadrons themselves (bootstrap condition). This type of model was first considered by Hagedorn, who obtained a solution of form $\rho(m) \sim cm^a e^{bm}$ with $a = -^5/_2$ which satisfied the bootstrap condition asymptotically to within a power of m. A solution with $a < -^5/_2$ is obtained which satisfies the bootstrap condition exactly in the high-mass limit. The constituents in the box are distributed with probability $P(n) = (\ln 2)^{n-1}/(n-1)!$; i.e., an average high-mass resonance decays (in the first generation of its decay chain) to two hadrons (69% probability) or three (24% probability). The thermodynamic applications of this model to high-energy scattering and astrophysics are briefly reviewed. (auth)

38731 SIMPLE DUAL-RESONANCE MODEL FOR INCLUSIVE REACTIONS. Virasoro, M. A. (Univ. of California, Berkeley). Phys. Rev., D; 3: No. 11, 2834-9(1 Jun 1971).

A dual expression is written for the differential cross section in two-body reactions for inclusive production of a single particle with definite momentum. The formula is similar to the usual five-point amplitude but where the range of integration has changed. It is shown that it describes both limiting fragmentation and pionization. It furthermore shows approximate factorization as a function of $p_\perp^2$ and $p_\parallel^2$. The asymptotic behavior in $p_\perp^2$ is universal. The formula is also generalized for inclusive reactions where n particles are detected. (auth)

38732 DESCRIPTION OF HIGH-ENERGY SCATTERING. Deo, B. B.; Parida, M. K. (Utkal Univ., Orissa, India). Phys. Rev. Lett.; 26: No. 25, 1609-11(21 Jun 1971).

A model of high-energy scattering is developed which incorporates assumed analytic properties. The approximations involved in the phenomenological fits of Orear and Krisch are discussed. An improved formula is suggested which has correct analytic properties and reproduces the Orear and Krisch fits in appropriate limits. (auth)

38733 CONTRIBUTION TO THE THEORY OF STRONG INTERACTIONS AT HIGH ENERGIES. Patashinskii, A. Z. (Novosibirsk State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.); 13: No. 2, 63-5(20 Jan 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 2, 92-5(20 Jan 1971).

The process of single photon annihilation e^+e^- into hadrons is considered. Also the collision between two hadrons is discussed. For this inverse process it is considered that the hadrons are two narrow disks always identical and homogeneous and that the colliding part constitutes a system similar to a γ quantum. (J.F.P.)

38734 DUAL ABSORPTIVE MODEL FOR DIPS IN INELASTIC HADRON PROCESSES. Harari, Haim (Stanford Univ., Calif.). Phys. Rev. Lett.; 26: No. 22, 1400-4(31 May 1971).

It is assumed that the imaginary part of any inelastic hadronic amplitude is dominated by the peripheral ($l \sim qr$) resonances, and that the same imaginary part can also be described by a combination of t-channel poles and cuts. The strength of the required cut term is determined by whether or not the pole term itself is already peripheral. The real part has no reason to be peripheral and can be determined easily from the peripheral imaginary part only when the cuts happen to be relatively weak. These assumptions lead to a successful qualitative description of all $|t| \sim 0.6$-GeV^2 dip effects in vector- and tensor-exchange inelastic and elastic reactions. (auth)

Strong (Baryon No. = 0)

38735 E-MESON DECAY IN THE VENEZIANO MODEL. Akiyama, Y.; Hori, S.; Yamada, E. (Kanazawa Univ., Japan). Phys. Lett.; 35B: No. 4, 314-16(7 Jun 1971).

It is shown that the pseudoscalar assignment for the E-meson is preferable in the Veneziano model. (auth)

38736 SMOOTH PION VERTICES: ρ AND K_{l3} DECAYS. Wise, Michael L. (State Univ. of New York, Stony Brook). Phys. Rev., D; 3: No. 11, 2767-74(1 Jun 1971).

It is shown that a new smoothness assumption for off-shell vertices involving pions determines the free parameter in the hard-pion study of the $\pi\rho A_1$ system predicting a ρ width of 135 MeV. Furthermore, for a given value of F_K/F_π this assumption determines, within the framework of pole dominance and (3,3*) ⊕ (3*,3) breaking of chiral symmetry, the K_{l3} decay parameters, κ-meson parameters, and the widths of the K* and K_A mesons. For example, if $F_K = F_\pi$ then $\xi \doteq -0.41$ and $\lambda_+ M_K^2/\mu_\pi^2 = 1.4$. (auth)

38737 OFF-MASS-SHELL VENEZIANO-TYPE AMPLITUDES AND π, K FORM FACTORS. Kanazawa, A. (Purdue Univ., Lafayette, Ind.); Haruyama, M. Phys. Rev., D; 3: No. 11, 2733-7 (1 Jun 1971).

The Veneziano-type amplitudes are constructed for the off-mass-shell scalar and vector amplitudes for the π-K system. These amplitudes are consistent with the constraints due to the current algebra and the model of Gell-Mann, Oakes, and Renner, and contain no free parameters. The soft-meson limits of these amplitudes are the π and K electromagnetic form factors, and the K_{l3} and K_{l4} form factors. All these form factors agree with the experiments except that the ratio $f_-(0)/f_+(0)$ remains small in the K_{l3} form factors. (auth)

38738 MODEL OF LOW-ENERGY PION–PION SCATTERING. Kang, J. S. (State Univ. of New York, Stony Brook); Lee, Benjamin W. Phys. Rev., D; 3: No. 11, 2814-20(1 Jun 1971).

A model of the low-energy pion–pion scattering amplitudes is constructed which is consistent with the usual partial-wave analyticity, elastic unitarity, and crossing symmetry in the s- and p-wave channels. The crossing relations are expressed as five Roskies conditions on the s- and p-wave amplitudes. The subtraction constants are chosen to agree with current-algebra constraints. The partial-wave amplitudes are constructed by the N/D method after approximating the left-hand singularities by a few poles. The pole structure is then determined self-consistently by requiring the Roskies conditions and the current-algebra conditions on the derivatives of the amplitudes at subtraction points to be satisfied. A solution is found which contains the ρ and σ mesons as dynamical bound states of the two-pion system. The resulting amplitudes, which should be a good approximation below 1 GeV, are in qualitative agreement with available experimental data. The I = 0, s-wave amplitude has a broad resonance at about 700 MeV. The location of the ρ meson is in agreement with experiment, but the width is somewhat larger than the experimental value. The I = 2, s-wave phase shifts are repulsive and small, in agreement with experiment. (auth)

38739 K-MATRIX MODEL OF THE LOW-ENERGY ππ SCATTERING. Afonin, A. A. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 13: No. 4, 882-6(Apr 1971). (In Russian).

The K matrix in the Born approximation is used to describe the low-energy ππ scattering. Only ρ- and f-meson exchange is taken into account. In doing so, without the introduction of σ meson, it is possible to obtain the large S wave ($\delta_0^0 \approx 80°$ at 1 GeV) at small scattering lengths $a_0 = 0{,}161\ \mu^{-1}$, $a_2 = -0{,}081\ \mu^{-1}$, $a_1 = 0{,}046\ \mu^{-2}$, that is consistent with predictions of the weakly broken SU(2) ⊗ SU(2) symmetry. The phase shifts and angular distribution are in reasonable agreement with the experimental data. (auth)

38740 DYNAMICAL DESCRIPTION OF THE ω MESON. Vall, A. N.; Serebryakov, V. V. (Inst. of Mathematics, Kiev). Yadern. Fiz.; 13: No. 4, 887-90(Apr 1971). (In Russian).

It is shown that the ω meson can be interpreted as a bound state of πρ system due to the ρ-meson exchange in the t channel. The main assumptions are connected with the bounds on the low partial waves and with the requirement of suppression of the channel with the isospin I = 2 in the total long-wave region of πρ scattering. The obtained connection between $g_{\rho\pi\pi}$ and $g_{\rho\pi\omega}$ is in agreement with the result of the SU(6) symmetry. (auth)

38741 POSSIBLE EXISTENCE OF LIGHT CHARGED BOSON. Domogatskii, G. V.; Zheleznykh, I. M.; Petrun'kin, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 13: No. 4, 810-16 (Apr 1971). (In Russian).

Lower bounds on masses of hypothetical charged scalar and vector particles are obtained from experimental data on the Lamb shift and the muon anamalous magnetic moment. The strongest bounds are obtained from the muon moment: $m_{sc} \gtrsim 3.7$ MeV, $m_v \gtrsim 230$ MeV. With some concrete assumptions on the shape of decay interaction of the hypothetical particle one is able to obtain additional bounds on properties of such particles from results of the neutrino experiments with reactors and accelerators. (auth)

Strong (Baryon No. = 1)

38742 (NYO-2262TA-243) INTERPRETATION OF A LARGE VALUE OF THE NUCLEON SIGMA COMMUTATOR. Olshansky, R. (Brown Univ., Providence, R. I.). [1971]. 5p. Dep. NTIS.

It is proposed that the value of the nucleon sigma commutator, σ_{NN}, calculated from π-N scattering data be used to determine what part of the average baryon mass is due to the chiral symmetry-breaking interaction. In the (3,3*) + (3*,3) model the large value of σ_{NN} reported previously then implies that the baryon mass vanishes in the SU(3) × SU(3) limit. Study of a Lagrangian model shows that this possibility need not conflict with the previous symmetry breaking Hamiltonian. (auth)

38743 (ORO-3992-58) SOME CONSEQUENCES OF A PIECEWISE ANALYTIC SCATTERING AMPLITUDE. Gundzik, M. G.; Sudarshan, E. C. G. (Texas Univ., Austin). Apr 1971. Contract AT(40-1)-3992. 35p. Dep. NTIS.

In the indefinite metric quantum field theory formulated previously and related work the scattering amplitude does not satisfy the usual Mandelstam analyticity. It becomes piecewise analytic at the threshold for the production of at least one of the negative metric particles of the theory, i.e., the amplitude above the threshold is not the analytic continuation of the amplitude. Some consequences of such a piecewise analytic scattering amplitude are investigated. The physical two body scattering amplitude G(s,t) is taken to be of the form: $G(s,t) = F(s,t) + h_1(s,t)\theta(s-s_0) + h_2(s,t)\theta(t-t_0) + h_3(s,t)\theta(u-u_0)$ where F(s,t) and the $h_i(s,t)$ are analytic functions of s and t with the negative metric thresholds occurring at $s = s_0$, $t = t_0$ and $u = u_0$ in the s, t and u channels, respectively. The modified forms of the Pomeranchuk theorem, dispersion relations and finite energy sum rules due to this general form of piecewise analyticity are derived and the interpretation of experimental results in terms of them are discussed. In particular, the modified forward dispersion relations for π^+p and π^-p scattering differ from the normal forms by a function $\xi(\nu)$ which depends on the piecewise analytic contributions $h_i(s,t)$ above, where ν is the laboratory momentum of the pion. The forward dispersion relations for the symmetric and antisymmetric combinations of the real part of the π^+p and π^-p scattering amplitudes $D^+(\nu)$ and $D^-(\nu)$, respectively, are tested. The best fits to the latest total cross section data for $\pi^\pm p$ scattering from 8 to 65 GeV/c which do not satisfy the Pomeranchuk theorem are used. No test for $D^-(\nu)$ which must be twice substracted is possible since it depends strongly on the πN coupling constant f^2 which is itself determined by dispersion relations. The result for $D^+(\nu)$ allows for a violation, but the evidence is not compelling. (auth)

38744 OPTICAL MODEL CONSISTENCY CONDITION BETWEEN THE REGENERATION PHASE AND THE REAL PARTS OF THE K^0–N FORWARD SCATTERING AMPLITUDES. Goldberg, H. S. (Univ. of Chicago); Telegdi, V. L. Phys. Lett.; 35B: No. 4, 327-30(7 Jun 1971).

Using just the magnitude of the regeneration amplitude it is shown that both the regeneration phase, φ_r, and the sum of the ratios of the real to imaginary parts of the K^0–N forward scattering amplitudes, γ_{pn}, can be determined for nuclei with zero or moderate neutron excess. The following is found: $\varphi_r = (43.5 \pm 2.5)^0$; $\gamma_{pn} = -0.73 \pm 0.1 + 1.7\bar{\gamma}_{pn}$ ⟨2.7 GeV/c⟩ $= -0.65 \pm 0.07 + 1.6\bar{\gamma}_{pn}$ ⟨4.5 GeV/c⟩, where $\bar{\gamma}_{pn}$ is corresponding quantity for $\bar{K}^0$–N scattering. Application to regeneration in hydrogen and the φ-meson are discussed. (auth)

38745 EXCHANGE DEGENERACY AND OSCILLATING TOTAL CROSS SECTIONS. Amann, R. F. (Syracuse Univ., N. Y.). Phys. Rev., D; 3: No. 11, 2861-4(1 Jun 1971).

The hypothesis that the Pomeranchukon consists, in part, of a pair of complex conjugate Regge poles, as suggested by Chew and Snider, is shown to allow exact exchange-degenerate fits to the high-energy total-cross-section data. A unique prediction of this hypothesis is that the ratio of real to imaginary parts for the amplitude for $\pi^-p \to \pi^-p$ scattering should not rise uniformly but rather rise to plateau, remain approximately constant from p_L = 20 to 60 GeV/c, then resume its rise. (auth)

38746 FORWARD–BACKWARD ASYMMETRY IN πp INELASTIC REACTIONS. Caneschi, Luca (Stanford Univ., Calif.). Phys. Rev., D; 3: No. 11, 2865-9(1 Jun 1971).

It is shown that the recently observed asymmetry between forward π^+ and backward π^- in inelastic π^-p interactions can be

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simply explained by kinematical considerations. The effect is a characteristic of the multiperipheral model, and a quantitative estimate is in excellent agreement with the data. (auth)

38747 THRESHOLD ENHANCEMENTS, IDENTICAL PARTICLES, AND DIFFRACTIVE DISSOCIATION. Young, Bing Lin; Donohue, J. T.; Peierls, Ronald F. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 3: No. 11, 2801-7(1 Jun 1971).

A discussion of some recent experimental results on threshold enhancements in the reaction $\pi^-p \rightarrow \pi^+\pi^-\pi^-p$ is given in terms of diffractive-dissociation model. In particular, an attempt is made to explain why the quasi-two-particle enhancements observed in $\pi_a^-(\pi^+\pi_b^-)$ for different $\pi^+\pi_b^-$ masses subsequently disappear when those $(\pi^+\pi_a^-)$ events in the ρ band are removed. The model is a double-Regge-exchange model symmetrized between the two identical pions. The parameters of the model are adjusted to fit the over-all 2π and 3π spectra, and the question of the enhancements and their disappearance is studied numerically. The model is able to reproduce the observed effects, provided a truncated Breit–Wigner line shape is used for the ρ meson. (auth)

38748 PION–NUCLEON CHARGE EXCHANGE AND THE CONSTANCY OF THE TOTAL CROSS SECTIONS AT ENERGIES ABOVE 30 GeV. Aznauryan, I. G.; Kut'in, V. M.; Solov'ev, L. D. (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.: 13: No. 4, 851-4(Apr 1971). (In Russian).

The dependence is analyzed of the pion–nucleon charge exchange under zero angle on the various assumptions about the constancy of difference of the total cross sections of π^-p and π^+p interactions at energies above 30 GeV. (auth)

38749 CALCULATION OF KN AND $\bar{K}N$ FORWARD SCATTERING AMPLITUDES FROM THE DISPERSION RELATIONS WITH THE VIOLATED POMERANCHUK THEOREM. Vishnevskii, M. E.; Galanina, N. D.; Nikolaev, N. N.; Chistilin, V. E. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: No. 4, 855-66(Apr 1971). (In Russian).

Real parts of the $K \pm N$ forward scattering amplitudes are calculated for the momenta from 0.9 up to 60 GeV/c based on the dispersion relations and the experimental data on the total cross sections. The calculations are done under various assumptions on the asymptotics of the total cross sections. The values are presented of the amplitude and phase of the K_2^0-meson regeneration and the $K^\pm$-meson charge exchange reactions on nucleons. The regeneration amplitudes for Cu and C nuclei are calculated in framework of the optical model. (auth)

38750 PARTIAL-WAVE ANALYSIS OF THE REACTION $\pi^-p \rightarrow \pi^+\pi^-n$. Makarov, M. M.; Gasilova, N. S.; Nelyubin, V. V.; Sarantsev, V. V.; Tkach, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 13: No. 4, 891-9(Apr 1971). (In Russian).

A relativistic partial-wave analysis of the reaction $\pi^-p \rightarrow \pi^+\pi^-n$ is carried out for the energies 350 to 500 MeV. The s, p, and d production of (3,3) isobar state from D_{13} and P_{11} states and statistical background from the P_{11} state are taken into account. The partial-wave amplitudes are determined analyzing the π^+-meson c.m.s. angular distribution and the two-particle angular distribution in the (π^-n) system in various parts of the Dalitz plot (according to various masses M_{π^-n}). The obtained values of the inelasticity are compared with the results of the phase-shift analysis of the elastic πN scattering. (auth)

38751 REGGEIZATION OF THE PION EXCHANGE IN THE REACTION $\pi + N \rightarrow \rho + N$. Zima, V. G. (Donetsk Physical-Technical Inst., USSR). Yadern. Fiz.; 13: No. 4, 878-81 (Apr 1971). (In Russian).

A possible method to reggeize the pion exchange in the reaction $\pi + N \rightarrow \rho + N$ is considered. The method is based on the comparison of the Regge amplitudes with Born amplitudes corresponding to the one-pion exchange with addition of the s- and u-channel nucleon exchange. (auth)

38752 CURRENT ALGEBRA AND KAON–NUCLEON SCATTERING LENGTH SUM RULES. Wada, W. W. (Ohio State Univ., Columbus). Nuovo Cim.; 3A: No. 4, 766-80(21 Jun 1971).

The method of Fubini and Furlan was used to obtain hard-kaon corrections to the current algebra values for the kaon-nucleon scattering amplitudes at physical threshold. Using the experimental values for the scattering lengths, several predictions were made on the low-energy kaon-nucleon interactions in the resonance approximation. It is shown that the unsubtracted dispersion relations and superconvergence relations which form the basis of the method are sufficient conditions for yet another derivation of the Adler–Weisberger low-energy theorem. (auth)

Strong (Baryon No. ≥ 2)

38753 EXPERIMENTAL WORK ON COHERENT SCATTERING OF HIGH-ENERGY HADRONS BY LIGHT NUCLEI. Fidecaro, G.; Fidecaro, M. (CERN, Geneva. Trieste High-Energy Group, Italy). pp 95-113 of Evolution of Particle Physics. /Conversi, M. (ed.). New York ; Academic Press Inc. (1970).

A review is given of results obtained thus far for the coherent scattering of high-energy hadrons from light nuclei. The forward scattering region, hadron–deuteron scattering, the A > 2 case, and the backward region are considered. (J.F.P.)

38754 COMMENTS ON NN → NNπ IN THE ISOBAR MODEL. Beder, D. S. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 49: 1445-7(1 Jun 1971).

An isobar model was examined for various charge modes of the reaction NN → NNπ, with careful attention to interference between isobar amplitudes. Interference was found to be important (contrary to earlier assumptions in the literature) for 600-MeV protons. The corrected predictions of the isobar model for ratios of $\pi^{+,-,0}$ total production cross sections are presented. (auth) (Canada)

38755 PION MULTIPLICITY AND REGGE TRAJECTORIES. Tomozawa, Y. (Univ. of Michigan, Ann Arbor). Phys. Lett.; 35B: No. 4, 331-4(7 Jun 1971).

Assuming that the zero multiplicity limit of the Poisson distribution in multiparticle production is related to the nondiffractive part of the elastic scattering cross section, the pion multiplicity expressed in terms of Regge parameters and other observable quantities is obtained. The agreement with the experimental data for the proton–proton reaction is reasonable. (auth)

38756 EFFECTS OF SPIN IN MULTIPLE-QUARK-SCATTERING ANALYSIS OF PROTON–PROTON SCATTERING. Thacker, W. C. (Univ. of Illinois, Urbana). Phys. Rev., D; 3: No. 11, 2774-82(1 Jun 1971).

Proton–proton scattering is investigated in a model in which the protons are composed of quarks and the scattering is due to multiple collisions of the quarks. By including spin in the calculation it was hoped that the differential-cross-section data could be described without resorting to quark amplitudes with t-dependent phases to remove dips which appear in the calculation. The conclusion is that the dips persist even when spin effects are included. (auth)

38757 Ad SCATTERING AS A PROBE OF THE ΛN CORE POTENTIAL. Kashef, Bayesteh Ghaffary (Univ. of Southern California, Los Angeles); Schick, L. H. Phys. Rev., D; 3: No. 11, 2661-70(1 Jun 1971).

Nonlocal separable (NLS), S-wave, spin-dependent, central potentials and a Faddeev formalism are used to solve the Ad scattering problem. The NN interaction is represented by an attractive NLS potential. Each of the ΛN interactions is represented by the sum of an attractive and a repulsive (core) NLS potential. Three different forms are used for this core potential, including no core at all. For a given ΛN spin each ΛN potential is adjusted to give the same low-energy scattering parameters, and the potentials with a core are adjusted to give the same phase shift over a wide energy range, as that given by a phenomenological local potential with a hard core. The ΛN wave functions and off-shell transition matrices are compared to see how each reflects the presence of the ΛN core potential. For incident Λ laboratory momentum in the range 100 to 300 MeV/c the Ad cross sections are reduced by (13–25)%, and they do depend on the off-shell behavior of the ΛN amplitude. (auth)

38758 CAN ONE SEE ISOBARS IN THE DEUTERON? Nath, N. R.; Weber, H. J.; Kabir, P. K. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett.; 26: No. 22, 1404-7(31 May 1971).

The reaction $\pi d \rightarrow N\Delta$ is studied as a probe of the $\Delta\Delta$ content of the deuteron. Assuming a Δ-exchange mechanism, the cross section is expected to be 10 to 100 μb at 1 GeV for an estimated probability of about 1% for the $\Delta\Delta$ configuration. (auth)

Particle Invariance Principles and Symmetries

Refer also to abstract 38629.

General

38759 SYMMETRY PRINCIPLES IN PHYSICS. Lee, T. D. (Columbia Univ., New York). pp 176-83 of Evolution of Par-

ticle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

Symmetry principles are discussed from an aesthetic point of view. Symmetries in nature and art, symmetries, nonmeasurables, and conservation laws, and symmetry violations are considered. (J.F.P.)

38760 DYNAMICS OF BROKEN SU(3) x SU(3). Brandt, Richard A. (New York Univ., N. Y.). Phys. Rev. Lett.; 26: No. 25, 1605-9(21 Jun 1971).

A method of using mass dispersion relations for relating symmetry-breaking parameters in Lagrangians to breaking effects in states and deducing precise relations between physical S-matrix elements from operator algebras is presented. The method is applied with the canonical equal-time and light-cone operator structures of the gluon model to deduce some SU(3) ⊗ SU(3) symmetry-breaking effects. $f_K/f_\pi \simeq 1.20$, $\xi(0) = -0.7$, a 50% correction to the Callan–Treiman relation, and $\alpha_8 \equiv$ [SU(3) breaking parameter] ≃ 0.14 GeV are found and an explanation is given of why these values are completely consistent with $Z_K/Z_\pi \gg 1$. (auth)

38761 DIMENSION OF CHIRAL AND CONFORMAL SYMMETRY BREAKING. Kleinert, H. (Freie Univ., Berlin); Weisz, P. H. Nuovo Cim.; 3A: No. 3, 479-90(1 Jun 1971).

The general consequences of Gell–Mann's decomposition of the energy density $\theta_{00}(x) = \theta^*_{00}(x) + \Sigma_n \delta_n(x) + u(x)$ are investigated, where u is the $SU_3 \times SU_3$ breaking term transforming according to a $(3\bar{3}) + (\bar{3}3)$ representation and being a Lorentz scalar of dimension d. It is shown that there must be at least two terms among θ^*_{00}, δ_n with nonvanishing vacuum expectation values. If it is further assumed that there are only two such terms with dimensions d′ and d″ one can obtain a new sum rule involving the spectral functions of the propagators of θ^μ_μ, $\partial^\mu A^\pi_\mu$ and $\partial^\mu A^K_\mu$, which reads

$$\int \rho_\theta(\mu^2)\frac{d\mu^2}{\mu^2} = X\left[\frac{r-2}{2r}\int \rho_\pi(\mu^2)\frac{d\mu^2}{\mu^2} + \frac{r+2}{r+1}\int \rho_K(\mu^2)\frac{d\mu^2}{\mu^2}\right]$$

where $r = -\frac{3}{2}(c + \sqrt{2})/c$ and $X = (d-d')(d''-d)$. Saturating with σ, π, K, one finds, using an earlier result on $g_{\sigma\pi\pi}$,

$$\frac{m_\sigma}{\Gamma_{\sigma\pi\pi}} = \frac{32\pi}{3m_\sigma^4} \times \left[\frac{r-2}{2r} f_\pi^2 m_\pi^2 + \frac{r+2}{r+1} f_K^2 m_K^2\right]\left(1 + [d-2]\frac{m_\pi^2}{m_\sigma^2}\right)^{-2}.$$

The experimental values $m_\sigma \approx 700$ and $\Gamma_{\sigma\pi\pi} \approx 400$ are used to estimate X in both the Gell–Mann–Oakes–Renner and the Brandt–Preparata $SU_3 \times SU_3$ symmetry-breaking schemes. Unfortunately, for reasonable values of f_K/f_π the sum rule does not distinguish between these two schemes, e.g., for $f_K/f_\pi = 1.25$, both schemes give $X \approx 3$. Nevertheless, this typical value allows one to conclude that σ dominance is consistent with many models not involving operators of anomalously high dimensions and at the same time it allows one to exclude many other models. (auth)

Applications (Electromagnetic and Weak)

38762 WEAK INTERACTIONS AND THE BREAKING OF HADRON SYMMETRIES. Cabibbo, N. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Maiani, L. pp 50-80 of Evolution of Particle Physics. /Conversi, M. (ed.). New York ; Academic Press Inc. (1970).

A review is given of previous work on a relation between the weak interaction angle and the symmetry-breaking parameters and the appearance of a nonelectromagnetic breaking of isotopic spin. An outline of hadron symmetries and their connection to weak interactions, a phenomenological analysis of symmetry breaking, attempts to understand the structure of symmetry breaking in terms of a purely strong interaction dynamics, and an analysis of the consequences of the nonelectromagnetic-isospin breaking with respect to $\eta \to 3\pi$ decay and to the mass splittings within isospin multiplets is discussed. Also reviewed are possible strong effects of weak interactions and the self-consistency requirement and its consequences. (J.F.P.)

38763 BREAKING OF THE SU_3 X SU_3 SYMMETRY IN HADRONIC PHYSICS. Michel, L. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France); Radicati, L. A. pp 191-203 of Evolution of Particle Physics. /Conversi, M. (ed.) New York; Academic Press Inc. (1970).

An extension of a previous geometrical approach is used to analyze the properties of strong, electromagnetic, and weak interactions from the point of view of the SU(3) × SU(3) group. (J.F.P.)

38764 SUGGESTION FOR A MORE PRECISE MEASUREMENT OF THE η_{+-} PHASE. Steinberger, J. (CERN, Geneva. Columbia Univ., New York). pp 268-72 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

It is pointed out that an improvement in the measurement of the η_{+-} phase of CP violation in the K^0 system can be made by measuring the mass difference with the same apparatus as the $\pi^+\pi^-$ interference term and simultaneously. The suggestion is to measure simultaneously with the $\pi^+\pi^-$ decay rate also the charge asymmetry in the lepton decay as a function of τ. (J.F.P.)

38765 IMPROVED ESTIMATE OF THE CP VIOLATION PARAMETERS FROM THE CONSEQUENCES OF UNITARITY. Gien, T. T. (Memorial Univ. of Newfoundland, St. John's). Can. J. Phys.; 49: 1120-3(1 May 1971).

The improved approximate expressions for η_{+-}, η_{00}, and Re ϵ are obtained with the model-dependent assumption of 2π saturation for the unitarity sum. The results are used to test again some models of CP noninvariance. In a certain model, the new value of $|\eta_{00}/\eta_{+-}|$ is found to be closer to the originally estimated value based on Re ϵ as input. (auth) (Canada)

38766 SINGLET–OCTET MIXING OF PSEUDOSCALAR MESONS IN BROKEN CHIRAL SYMMETRY. Samuel, Mark A. (Oklahoma State Univ., Stillwater). Phys. Rev., D; 3: No. 11, 2912-13(1 Jun 1971).

The results of Pande for $\eta - X^0$ mixing in broken chiral SU(3) ⊗ SU(3) symmetry are examined. Since there is strong evidence for three I = Y = 0 pseudoscalar mesons, the model is extended to describe mixing of the pure octet member and two SU(3) singlets. Here, there are two parameters, whose values are determined by using the $X^0(958)$ and E(1422) masses as input. Then a prediction is obtained for the mass of the η, in very good agreement with the experiment. The mixing parameters, both magnitude and sign, are also obtained. (auth)

38767 IS CP-INVARIANCE VIOLATION CAUSED BY AN SU(3) SINGLET. Nuyts, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Rev. Lett.; 26: No. 25, 1604-5(21 Jun 1971).

A theorem is proved which shows that if CP-invariance violation originates in a semistrong and/or electromagnetic — or in fact any — interaction belonging to a (3*,3) ⊕ (3,3*) representation of SU(3) ⊗ SU(3), the CP-invariance-violating term is a pure singlet of SU(3). (auth)

38768 IS PARITY VIOLATED IN WEAK INTERACTIONS? Gomberoff, L. (Tel-Aviv Univ., Israel); Tolmachev, V. Nuovo Cim.; 3A: No. 4, 657-62(21 Jun 1971).

The possibility of understanding weak interactions without violation of parity, by introducing pseudoscalar charges, is discussed. These pseudoscalar charges would transform under parity as the hypothetical magnetic monopoles. (auth)

Applications (Strong)

Refer also to abstract 38742.

38769 (NYO-2262TA-242) CHIRAL SYMMETRY BREAKING OF THE VACUUM. Olshansky, R. (Brown Univ., Providence, R. I. Dept. of Physics). [1971]. 9p. Dep. NTIS.

The chiral symmetry breaking of the vacuum is studied in the linear σ-model. It is found that an approximately SU(3) symmetric vacuum can explain the observed spin-zero mass spectrum, the quantity $f_K/f_\pi f^+(0)$, and the mass splitting of the baryon octet. The results support a previous conclusion that the symmetry breaking Hamiltonian possesses approximate SU(2) × SU(2) symmetry. The detailed structure of the Lagrangian favors the Goldstone realization of full SU(3) × SU(3) symmetry. (auth)

38770 BASIC SU_3 MIXING: (ω − ϕ). Zichichi, A. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). pp 299-334 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

The (ω − ϕ) mixing including the first direct measurement of the (ω − ϕ) mixing angle is reviewed. The four mixing angles and the vector-meson–photon interaction are discussed. (J.F.P.)

38771 GENERAL TREATMENT OF THE BREAKING OF CHIRAL SYMMETRY AND SCALE INVARIANCE IN THE SU(3) σ MODEL. Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y.). Phys. Rev., D; 3: No. 11, 2874-93(1 Jun 1971).

The model of nine scalar and nine pseudoscalar fields interacting by means of the most general nonderivative chiral SU(3) × SU(3) invariant and any particular symmetry-breaking term is studied. Two basic "generating" equations which express the complete con-

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tent of chiral symmetry are derived. The masses and coupling constants of arbitrary order for this model are simply found by differentiating the "generating" equations an arbitrary number of times and using an equation which expresses the stability of the "ground" state. In this way, previous results on this model can be easily recaptured and a systematic framework for the investigation of different symmetry-breaking terms is provided. Numerical estimates are made for scalar-meson widths, $\pi\pi$ and πK scattering lengths, and $\eta' \rightarrow \eta 2\pi$ decays. The consequences of imposing scale invariance on the invariant part of the interaction are also investigated by writing down a scale invariance "generating equation." Finally, the relation between our approach and the method of using the divergences of currents and trace of the energy-momentum tensor is discussed. (auth)

Field Theories

General

38772 DISTRIBUTION OF EIGENFREQUENCIES FOR THE WAVE EQUATION IN A FINITE DOMAIN. II. ELECTROMAGNETIC FIELD. RIEMANNIAN SPACES. Balian, R.; Bloch, C. (CEN, Saclay, France). Ann. Phys. (N. Y.); 64: No. 1, 271-307(May 1971).

Two extensions of previous work are discussed. The distribution of electromagnetic eigenmodes in a cavity with perfectly conducting smooth walls is evaluated, yielding, in particular, size corrections to Planck's law for the blackbody radiation. The smoothed density of eigenmodes is also evaluated for the scalar wave equation on a Riemannian manifold of any dimension, with the same general boundary conditions as previously. The derivation is based on a local approximation method, giving rise to expansions in terms of the curvatures of the manifold and of its boundary. (auth)

38773 PHYSICAL SIGNIFICANCE OF THE VECTOR POTENTIAL. Janossy, L. (Central Research Inst., Budapest). Acta Phys. Acad. Sci. Hung.; 29: No. 4, 419-25(1970).

It was previously claimed that the vector potential of an electromagnetic field plays a specified role which is a characteristic quantum mechanical effect. In the analysis below it is shown that this is not so but that the role of the vector potential can be understood without supposing a specific quantum mechanical action. (auth)

Quantum Field Theory

Refer also to abstracts 38636 and 38802.

38774 (CEA-R-4142) USES OF THE CLASSICAL APPROXIMATION IN QUANTUM ELECTRODYNAMICS. Brezin, Edouard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1971. 108p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences.

Approximations commonly used in the study of the classical limit of quantum mechanics are applied, with justification, to quantum electrodynamics. First, the infra-red divergence in the scattering of two charged particles is examined with the help of a remarkable series of Feynman diagrams, which in particular preserves gauge invariance and a correct static limit. Looking for the poles in energy of the scattering amplitude, a formula for the binding energies of two charged particles, which generalizes the Balmer formula and takes into account the correct relativistic kinematics, was derived. A second type of applications concerns phenomena due to the interaction of the electromagnetic field with the vacuum-current and charge fluctuations. For instance, when the intensities become very high, the theory predicts the creation of electron-positron pairs by the field. The creation rate is known in the limit of static fields, and the aim of these calculations was to demonstrate the role of frequency in the domain starting from the lowest frequencies up to X rays. The pair production rate was found to be entirely negligible, even for the most intense laser beams. An increase in frequency, even up to several tens of keV, did not have any effect on the pair production. (France)

38775 (CEA-R-4187) ALGEBRAIC AND ANALYTICITY PROPERTIES OF THE n-POINT FUNCTION IN QUANTUM FIELD THEORY. Bros, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1971. 127p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences.

The general theory of quantized fields (axiomatic approach) is investigated. A systematic study of the algebraic properties of all the Green functions of a local field, which generalize the ordinary retarded and advanced functions, is presented. The notion emerges of a primitive analyticity domain of the n-point function, and of the existence of auxiliary analytic functions into which the various Green functions can be decomposed. Certain processes of analytic completion are described, and then applied to enlarging the primitive domain, particularly for the case n = 4; among the results the crossing property for all scattering amplitude which involves two incoming and two outgoing particles is proved. (France)

38776 (NP-18859) TO THE QUESTION OF THE LIMITING TRANSITION TO ZERO MASS AND RENORMALIZABILITY IN THE MASSIVE YANG-MILLS FIELD THEORY. Khriplovich, I. B.; Vainshtein, A. I. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1970. 29p. Dep. NTIS (U. S. Sales Only).

It is shown that in perturbation theory for the massive Yang-Mills field there is no continuous limiting transition to zero mass and the theory is unrenormalizable. These results are the consequence of the singularity of zero helicity (three-dimensionally longitudinal) quanta interaction, the singularity which is absent for the neutral vector field. The generalization of the radiation gauge to the nonzero mass case is built. In this description the interaction of three-dimensionally longitudinal quanta is extracted explicitly. The consideration in this formalism makes extremely likely the assertion of the existence of continuous limiting transition to zero mass and of renormalizability beyond the perturbation theory. (auth)

38777 SOME QUESTIONS CONCERNING ADIABATIC TRANSFORMATIONS. Wick, G. C. (CERN, Geneva). pp 287-93 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

The situation is discussed which arises when a coupling constant is switched on exponentially, $g(t) = g \exp(\alpha t)$ and the adiabatic limit is obtained for $\alpha \rightarrow 0+$. For finite α the state Ψ_g attained by the system at the time $t = 0$ satisfies a well known differential equation with respect to the coupling constant g. It is noted that a much simpler and more transparent derivation can be given without resorting to a previously given perturbation expansion. The differential equations, the adiabatic limit, and extension of the calculations are considered. (J.F.P.)

38778 RECONSTRUCTION THEOREM WITH EXTERNAL SOURCES. Capri, A. Z.; Labonte, G.; Menon, D.; Shamaly, A. (Univ. of Alberta, Edmonton). Nuovo Cim., 3B: No. 2, 233-44 (11 Jun 1971).

Wightman's reconstruction theorem for a neutral scalar field is extended to permit external interactions as well. The result is illustrated for a neutral scalar field interacting with a c-number source only. (auth)

38779 LOCAL AND UNITARY APPROXIMATION TO COMMUTATORS. Dahmen, H. D.; Gromes, D.; Rothe, K. D.; Stech, B. (Univ., Heidelberg. Kernforschungszentrum, Karlsruhe, Ger.). Phys. Lett.; 35B: No. 4, 335-9(7 Jun 1971).

The saturation of commutator matrix elements is extended to include two particle cuts. For the case of vacuum one particle matrix elements, a complete solution fulfilling locality and elastic unitarity is given. (auth)

38780 ANALYTIC 4th ORDER CROSSED LADDER CONTRIBUTION TO THE LAMB SHIFT. Peterman, A. (CERN, Geneva). Phys. Lett.; 35B: No. 4, 325-6(7 Jun 1971).

A systematic investigation is made of the work of Soto. The algebra is redone entirely. The integrals are tested numerically. Each dubious or litigious integral is recomputed analytically. The contribution to the 4th order slope at zero momentum transfer is found in the Feynman gauge. (auth)

38781 STUDY OF CHIRAL SU(2) ⊗ SU(2) CURRENT-ALGEBRA MODELS. II. PHENOMENOLOGICAL LAGRANGIANS. Vaughn, Michael T. (Univ., Vienna. Northeastern Univ., Boston). Phys. Rev., D; 3: No. 11, 2738-43(1 Jun 1971).

The hard-pion effective Lagrangians of Arnowitt et al. are derived from a Lagrangian invariant under local chiral gauge transformations of the Yang-Mills type, except for a vector-meson mass term, which leads to the field-current identity, and a σ term, which leads to partial conservation of axial-vector current. The effect of other chiral-invariant terms, which break the local gauge invariance, is discussed. (auth)

38782 ELECTROMAGNETISM DEDUCED FROM ELECTROSTATICS AND RELATIVITY. PART I. Schreiden, Andre (Univ.

Officielle du Congo, Lubumbashi). Ann. Soc. Sci. Brux. Ser. I; 85: No. 1, 39-82(25 Apr 1971). (In French).

Starting from the equations of electrostatics (and classical dynamics), the equations of electromagnetism are built with the help of the relativity principle (i.e., invariance in Minkowski space). Such a procedure is called relativistic extension. This method is in fact an improvement of the method that is called covariant extension, which is well known. The procedure of relativistic extension will also appear as a simplification of a previous construction of electromagnetism from electrostatics and relativity. (auth)

38783 QUANTUM FIELDS AND INTERACTIONS OF MASSLESS PARTICLES: THE CONTINUOUS SPIN CASE. Iverson, Geoffrey J.; Mack, Gerhard (Univ. of Miami, Coral Gables, Fla.). Ann. Phys. (N. Y.); 64: No. 1, 211-53(May 1971).

Among the unitary irreducible representations of the Poincaré group discovered by Wigner, there occurs a class of mass zero representations which are, for historical reasons, usually referred to as continuous spin representations, and are labeled by values of the Casimir invariants $P^2 = 0$, $W_\mu W^\mu = -\rho^2$, with $\rho > 0$. A corresponding particle can exist in a denumerable set of helicity states λ, with λ taking either all integer values $\lambda = 0, \pm1, \pm2, \ldots$ or all half-odd integer values $\lambda = \pm\frac{1}{2}, \pm\frac{3}{2}, \ldots$. Free quantum fields are constructed for such particles and also their interactions to lowest order in the coupling constant are studied. The fields are of necessity infinite component fields, and their commutator is found to vanish at most in proper subsets of the spacelike region. Particular attention is paid to the behavior of the theory for small ρ. In the limit $\rho \to 0$, the fields go over into those given previously for the description of a single ordinary massless particle with fixed helicity. The limiting behavior of S-matrix elements is also studied, and it is demonstrated how predictions of conventional finite component field theory, including the helicity selection rules, can be recovered in the limit $\rho \to 0$. The interactions studied are at least quadratic in the fields of continuous spin particles. Currents and interaction Hamiltonians which contain them only linearly need a separate investigation. This will be carried out subsequently. (auth)

38784 FUNCTIONAL TECHNIQUES IN PHYSICS. Fradkin, E. S.; Esposito, U.; Termini, S. (CNR, Naples). Riv. Nuovo Cim.; 2: No. 4, 498-560(Oct-Dec 1970).

Some results obtained previously using functional techniques are collected. The general technique is given, and applications are made to quantum field theory. It is noted that the approach allows the introduction of a modified perturbation theory. Functional equations for the S-matrix, solvable models and approximations, operator continual solutions for Green's functions in the external field and the modified perturbation approach, application of the method of stationary phase to the operator solution of Green's functions, and construction of the generating functional for Yang–Mills and gravitational fields are covered. (J.F.P.)

38785 GHOSTLESS LEE MODEL. Cunningham, J. (University Coll. of North Wales, Bangor). Acta Phys. Acad. Sci. Hung.; 29: No. 4, 373-8(1970).

A static model in which a point nucleon may emit an infinite number of light relativistic bosons is constructed. By suitable choice of coupling constants the model may be made free from ghost states. (auth)

38786 CONSTRAINTS ON GRAVITATIONALLY COUPLED TENSOR FIELDS. Aragone, C. (Univ. de la Republica, Montevideo); Deser, S. Nuovo Cim.; 3A: No. 4, 709-20(21 Jun 1971).

The solutions of pure spin-two field equations in the presence of gravitation are shown to be strongly constrained by consistency requirements on the equations. Addition of nonminimal gravitational coupling cannot remove these difficulties. (auth)

38787 MASS-EIGENVALUE PROBLEM IN A NEUTRAL PSEUDOSCALAR MESON THEORY WITH INDEFINITE METRIC. Marioni, C. (Univ., Milan); Montaldi, E. Nuovo Cim.; 3A: No. 4, 781-95(21 Jun 1971).

Recent methods using an indefinite metric are applied to the study of the mass-eigenvalue problem of a conventional pseudoscalar meson theory. In this new theory all quantities are finite and only two independent parameters appear: the bare coupling constant G_0 and the bare nucleon mass m_0. G_0 determines the ratio between the pion and nucleon masses; m_0 is a scale factor fixing the unity of masses. (auth)

38788 ALGEBRAIC TREATMENT OF NONRELATIVISTIC AND RELATIVISTIC QUANTUM EQUATIONS AND ITS RELATION TO THE THEORY OF DIFFERENTIAL EQUATIONS. Cordero, P. (Univ. de Chile, Santiago); Hojman, S.; Furlan, P.; Ghirardi, G. C. Nuovo Cim.; 3A: No. 4, 807-21(21 Jun 1971).

The algebraic treatment of the eigenvalue equations for quantum systems, based on the introduction of the spectrum-generating algebra $SO_{2,1}$, in the sense of a previous work, is generalized by allowing energy-dependent realizations of the algebra. A basic differential equation is derived, which expresses in a concise way the conditions that the Hamiltonian of the system must satisfy in order that an algebraic treatment, within our framework, be possible. The formalism is such that it allows a straightforward and unified rederivation of all results previously obtained by algebraic methods both for the nonrelativistic and relativistic cases, and also, to some extent, a discussion of the Dirac equation with an electrostatic potential, which has not been solved algebraically up to now. Moreover, the obtained equation yields in a natural way the link between the algebraic treatment of quantum systems based on the $SO_{2,1}$ algebra and the theory of differential equations. It is shown that the conditions that the system must satisfy in order to have $SO_{2,1}$ as spectrum-generating algebra in our sense lead to the same condition as the one obtained by imposing that the Schroedinger equation can be reduced, by means of a functional transformation, to the confluent hypergeometric equation. This result is particularly interesting since all quantum-mechanical systems that have been solved algebraically up to now possess $SO_{2,1}$ as spectrum-generating algebra. (auth)

38789 INFINITE-COMPONENT FREE FIELD CARRYING COMPOUNDS LYING ON A REGGE TRAJECTORY. Van der Spuy, E. (Atomic Energy Board, Pelindaba, S. Afr.). Nuovo Cim.; 3A: No. 4, 422-46(21 Jun 1971).

An infinite-component generalized free field $\varphi(x)$ is constructed which carries an infinite tower of unstable (excepting the lowest-mass member) self-compounds which is defined by a spin trajectory. $\varphi(x)$ transforms locally under the Poincaré group. The norm or propagator of $\varphi(x)$ can be written as an infinite partial (in spin j) series of contributions of positive-definite metric, which, with the suggested constraint on the mass^2 (squared) function m_j^2 as $|j| \to \infty$, permits summation by the Sommerfeld–Watson transformation. In close analogy to the Gupta–Bleuler form of quantum electrodynamics, the consequent Reggeized propagator then involves contributions of indefinite metric completely equivalent to the positive-metric partial series. The indefinite metric is here directly associated with the instability of the higher Regge poles. The constraint on m_j^2, together with the effect of invariance under TP for the φ propagator leads to a particular dispersion relation for our mass^2 function m_{AZ}^2. The latter involves $\Lambda = (j + \frac{1}{2})^2$, $Z = P^2$ the four-momentum squared, on a completely reciprocal basis. It also, necessarily, introduces two mass^2 continua ($r > 4m_0^2$, $r < 0$). The latter, tachyon component suggests that φ has to be interpreted as a fundamental field which is not directly observed. The phenomenological field having no tachyon component and which is directly observed will be discussed on the basis of unitarity in a subsequent paper. The propagator of the free field φ clearly obeys unitarity in a trivial way in terms of the free states defined by itself. (auth)

38790 OBSERVABLE PROCESSES CORRESPONDING TO A FUNDAMENTAL FIELD. Van der Spuy, E. (Atomic Energy Board, Pelindaba, S. Afr.). Nuovo Cim.; 3A: No. 4, 847-56(21 Jun 1971).

The amplitude for elastic scattering corresponding to a neutral, fundamental field is constructed. The fundamental field $\varphi(x)$ can be written as a generalized free field which transforms locally under the Poincaré group, and has a propagator which by analytic continuation can be shown to carry an infinite tower of spinning self-compounds lying on a Regge trajectory. The propagator of the neutral field is invariant under TP. To construct the amplitude, all phenomenological asymptotic states of one, two, three, etc. particles corresponding to the discrete, stable mass component of the fundamental field are first constructed. These states, used as a complete set of intermediate states, enable one in principle through unitarity of $\Delta^+_{\alpha\beta}(x - y) = \langle 0|\varphi_\alpha(x)\varphi^\dagger_\beta(y)|0\rangle$ to calculate the vertex function of these phenomenological states with respect to the fundamental field. These vertex functions can then be used to determine the corresponding scattering amplitude: for example, the elastic-scattering amplitude of two mass-m_0, spin-0 particles. For the latter one uses unitarity again and in fact in the states of the fundamental free field. A preliminary investigation is made of the determination of these observable scattering amplitudes corresponding to a fundamental field. The elastic-scattering amplitude can be continued in the angular momentum under the same conditions as the propagator of the fundamental field, and the spin trajectory is completely determined by the spectral function of this propagator. (auth)

Gravitation and General Relativity

38791 EXTRA-DIMENSIONALITY IN GENERAL RELATIVITY AND THEORY OF SPACEON STRUCTURES. Gregory, C.

(Univ. of Hawaii, Honolulu). Nuovo Cim., 3B: No. 2, 206-12 (11 Jun 1971).

Quantization of the partial differential equations of motion obtained from an application of the Einstein, Infeld and Hoffmann method of a 4 + 1 space leads to the concept of spaceons. The vacuum expectation value of the Hamiltonian for two particles involves a potential-energy contribution $V(r) = -(A/r) \int_{\theta}^{\infty} \exp[-t^2/2]\, dt$, where A and σ are parameters depending on charge, mass and two additional ones with dimension of length and mass. The use of observations from electron–proton scattering, which suggest a Gaussian distribution, when applied here implies a periodicity length of 3050 m in the additional dimension and that the lowest nonzero energy for a spaceon associated with the electron is $\sim 10^3$ GeV. For the proton, however, the energy of the associated spaceon is ~0.5 GeV. (auth)

38792 SYMMETRIES OF STATIONARY AXISYMMETRIC EMPTY SPACE–TIMES. Collinson, C. D.; Dodd, R. K. (Univ. of Hull, Eng.). Nuovo Cim., 3B: No. 2, 281-94(11 Jun 1971).

The symmetries of stationary axisymmetric empty space-times are investigated using the null tetrad notation of Newman and Penrose. An empty space-time of Petrov type II admitting a non-trivial symmetry is exhibited, thus contradicting a general result of Bialas and Bialas based on work by Petrov. (auth)

38793 MODIFICATION OF SACHS' SYMMETRIC-TENSOR–ANTISYMMETRIC-TENSOR THEORY FROM A QUATERNION REPRESENTATION OF GENERAL RELATIVITY. Datta, B. K. (Univ., Stuttgart). Nuovo Cim., 3B: No. 2, 171-82(11 Jun 1971).

A recent theory of Sachs in which the quaternion field equations in the framework of general relativity are shown to be equivalent to a symmetric-tensor–antisymmetric-tensor formalism is reconsidered in a modified form. These modifications consist mainly in using a general asymmetric affine connection and a matter Lagrangian density which is a function of spin connection in accordance with the covariance principle. Invariance of this Lagrangian under infinitesimal coordinate and spin transformations leads to the identities which demonstrate that the antisummetric part is, in this case, related to the spin angular momentum. Applying the usual variational formalism, the field equations are derived, which are shown to be consistent with the invariance identities. (auth)

38794 PIONIC ATOM IN THE THEORY OF THE GENERALIZED GRAVITATIONAL POTENTIAL. Cherry, N. H. (Drexel Univ., Philadelphia). Nuovo Cim., 3B: No. 2, 183-92(11 Jun 1971).

A general-relativistic scalar field theory in the complex Weyl space is applied to the pionic atom. In particular the wave equation of the pion for stationary states is derived and from this equation the radial equation for these states is obtained. The radial equation is then used in an approximation method for $Z \gtrsim 12$ to obtain the difference in energy between that predicted by the present theory and that predicted by Klein–Gordon theory for the π-mesonic x-rays. This energy difference is then compared to the energy difference obtained between experiment and Klein–Gordon theory and the nucleon core radius as predicted by this theory is thus obtained. The theory is found to predict a repulsive nuclear force, a nucleon core radius of (0.76 + 0.78) fm and to correlate well with experiment for the low-Z isotopes considered. (auth)

38795 GLOBAL AND LOCAL PRINCIPLES OF RELATIVITY. Treder, Hans-J. (Zentral Institut fuer Astrophysik, Babelsberg, Ger.). Found. Phys.; 1: No. 1, 77-94(1970).

The principles of relativity are assertions about the structure of physical laws, whose validity or nonvalidity can only be empirically confirmed or falsified. The weakest forms of those principles are the so-called global propositions. They furnish statements as to which operations—assumed to be performed simultaneously throughout the whole universe—have no influence upon the physical events. Much stronger principles are those of a local nature. These assert that the physical properties of a system do not change, when the relation of the system is altered vis-à-vis the universe at large. On formulating these local principles, it is presupposed either that it is possible to eliminate any influence of the environment or that the influence can be compensated as in the case of universal forces (e.g., gravitational) which can principally not be removed. Still weaker, however, are those formulations of the relativity principles which postulate relativity only for infinitesimally small space–time domains or regions. This distinction yields clarification of all discussions about existence and meaning of a general relativity principle. Such an analysis was already performed by Einstein and Abraham in 1912. (auth)

38796 WEBER'S ANTENNA AND THE RADIATION SOURCES. Madore, J.; Papapetrou, A. (Univ., Paris). Ann. Inst. Henri Poincare, Sect. A: 14: No. 2, 139-51(1971).

Some questions concerning the relation between events detected by a Weber antenna and gravitational radiation sources are discussed. (France)

38797 NEW METHOD OF SEARCH FOR LOW-FREQUENCY GRAVITATIONAL WAVES. Bergmann, Peter G. (Syracuse Univ., N. Y.). Phys. Rev. Lett.; 26: No. 22, 1398-1400(31 May 1971).

It is proposed to search for low-frequency components of gravitational waves by attempting to detect intensity fluctuations of light that has traveled over transmission paths crossed by gravitational waves. (auth)

Scattering Theory

38798 (NYO–2262TA-240) DISCONTINUITY FORMULAE AND A DERIVATION OF MUELLER'S REGGE HYPOTHESIS FOR INCLUSIVE CROSS SECTIONS. Tan, Chung I. (Brown Univ., Providence, R. I. Dept. of Physics). [1971]. 27p. Dep. NTIS.

It is proposed to interpret recent work on inclusive cross sections in terms of the elementary discontinuity equations for multiparticle scattering amplitudes. The paths of continuity for obtaining these discontinuities are given. It is found that, in order to make the identification meaningful, the emergence of anomalous thresholds is necessary to "shield" the effects of box-diagram Landau singularities. It is demonstrated how Mueller's Regge hypothesis can be derived from the multi-Regge models, where singularities other than normal thresholds are absent in the asymptotic limits. (auth)

38799 (OU–LNS–71-4) OPERATOR FORMALISM OF DUAL RESONANCE MODEL WITH DIFFERENT TRAJECTORIES. Konisi, Gaku; Saito, Takesi (Osaka Univ. (Japan). Lab. of Nuclear Studies). May 1971. 31p. Dep. NTIS (U. S. Sales Only).

In the dual resonance model the generalized harmonic oscillator formalism is constructed when relevant particles lie on different trajectories. Requiring the factorization in the sense of the operator method, one can see that the Regge intercepts are expressed in terms of quark quantum numbers. Propagator, general vertex, gauge operator and so on, appearing in the usual dual resonance model with a single trajectory, are redefined. The duality of the four-point tree diagram between general nonspurious virtual states can also be shown. (auth)

38800 REGGE THEORY AND PARTICLE PHYSICS. Collins, P. D. B. (Univ. of Durham, Eng.). Phys. Rep.; 1C: No. 4, 103-233(Jun 1971).

An introductory review of the applications of complex J-plane theory, or Regge theory, to the analysis of elementary particle processes is given. It is described how a helicity amplitude may be represented in terms of its J-plane singularities, and the restrictions which can be placed on those singularities. The properties of Regge poles and cuts, and the evaluation of cut contributions are discussed, and the concept of duality, and the formulation of dual models are considered. The way in which information about the Regge singularities can be deduced from the experimental data, both from the resonance spectrum and from the high-energy behavior of scattering amplitudes, is described, and an attempt is made to assess the current state of Regge phenomenology and its place in particle physics. (auth)

38801 DISTORTION OPERATOR APPROACH AND [N,1] PADE SEQUENCE IN NONRELATIVISTIC SCATTERING THEORY. Michalik, B. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 21: No. 6, 591-603(1971).

A brief account of the scattering theory using the so called distortion operator is given. The Neumann series for a matrix element of the distortion operator is proved to imply the [N, 1] Padé sequence for the transition matrix element. As a consequence, a region of convergence of the [N, 1] Padé sequence is found. (auth)

38802 PARTIAL DIAGONALIZATION OF ABSORPTIVE PART EQUATIONS BY LAPLACE TRANSFORMS. Abarbanel, H. D. I.; Saunders, L. M. (Princeton Univ., N. J.). Ann. Phys. (N. Y.); 64: No. 1, 254-70(May 1971).

A Laplace transform is developed to perform a crossed-channel partial wave analysis of Bethe–Salpeter equations for absorptive parts of nonforward scattering matrix elements involving particles

with spin. The method requires no rotation of contours and allows from the outset power growth in energy of the absorptive part. Diagonalization of the equation with an arbitrary kernel is explicitly carried out, thereby reducing it from a four-dimensional equation to a two-dimensional one. The analysis makes continual use of the underlying SO(1,2) group symmetry in choosing kinematic variables, defining the transform and proving the crucial addition theorem necessary to effect the diagonalization. (auth)

38803 DIFFERENTIAL APPROACH TO HIGH-ENERGY BEHAVIOUR OF FEYNMAN AMPLITUDES. Cunningham, J. (University Coll. of North Wales, Bangor). Acta Phys. Acad. Sci. Hung.; 29: No. 4, 379-81(1970).

Asymptotic behavior for the "box" scattering diagram is determined using partial differential equations for the amplitude rather than the usual integral representations. (auth)

38804 CONDITION ON THE NONRELATIVISTIC SCATTERING AMPLITUDE FOLLOWING FROM THE POTENTIAL LOCALITY. Beloozerov, N. N. (All-Union Inst. of Scientific and Technical Information, Moscow). Yadern. Fiz.; 13: No. 4, 900-3(Apr 1971). (In Russian).

A necessary and sufficient condition is obtained that the given function F(p,q,E) is the scattering amplitude for a local potential. A similar condition is obtained for the energy independence of the potential. The restrictions on the amplitude dependence on other parameters of the potential are discussed. (auth)

38805 REPRESENTATIONS OF THE O_4 GROUP APPEARING IN THE FIVE-BODY PROBLEM. Kil'dyushov, M. S.; Surkov, E. L. (Moscow Physical-Technical Inst.). Yadern. Fiz.; 13: No. 4, 904-12(Apr 1971). (In Russian).

Polynomial bases corresponding to reductions $O_4 \sim O_3 \otimes O_3 \supset O_2 \otimes O_2$ and $O_4 \supset O_3 \supset O_2$ are constructed for arbitrary irreducible representations of the O_4 group. Corresponding matrix elements are calculated. For the matrix elements of the canonical basis, a differential equation is derived and a recurrent relation and an integral representation are obtained. The relation of the polynomials constructed with the "tree" functions and the plane three body problem is shown. (auth)

38806 REGGEON-PARTICLE AND REGGEON-REGGEON SCATTERING AMPLITUDES IN THE VENEZIANO MODEL. Laperashvili, L. V.; Safro, M. G. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 13: No. 4, 867-77(Apr 1971). (In Russian).

Reggeon-particle and reggeon-reggeon scattering amplitudes are calculated within the Veneziano model factorizing the eight-point vertex at a definite choice of the asymptotic behavior corresponding to the Gribov's graph specific for the two-reggeon cuts. Using the amplitudes obtained the contribution is calculated to the four-point vertex from the sum of graphs consisting of the chain of n two-reggeon loops. The summation of "nonenhanced" chain graphs results in appearance of the effective Regge poles. (auth)

38807 PERTURBATIVE UNITARITY OF DUAL LOOPS. Frampton, P. H.; Goddard, P.; Wray, D. A. (CERN, Geneva). Nuovo Cim.; 3A: No. 4, 755-62(21 Jun 1971).

The N-loop dual graphs are classified and enumerated in terms of integration contours on a sphere with N handles. Perturbative unitarity at the leading Landau singularity dictates that all inequivalent N-loop diagrams (unrelated by duality) be added with equal weight. A proof of perturbative unitarity for the resulting expansion is hindered by the presence of complex anomalous thresholds. (auth)

38808 NO-GO THEOREMS FOR DUAL MODELS (ADDENDUM). Frampton, P. H. (CERN, Geneva). Nuovo Cim.; 3A: No. 4, 763-5(21 Jun 1971).

Previous results concerning the difficulty of multiplicative modification of an N-particle dual amplitude are extended. (auth)

Particle Accelerators

Refer also to abstracts 37674, 38628, 38629, and 39123.

38809 (A/CONF.49/P-52) LOS ALAMOS MESON PHYSICS FACILITY, A NEW TOOL FOR BASIC RESEARCH AND PRACTICAL APPLICATIONS. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). Sep 1971. Contract W-7405-eng-36. 17p. (CONF-710901-27). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Los Alamos Meson Physics Facility (LAMPF), designed to accelerate a 1-mA 800-MeV beam of protons and a 100-μA beam of negative hydrogen ions simultaneously, is described. Secondary beams of pions and muons that are 1000 times more intense than those presently available will be produced. The many purposes of LAMPF are reviewed, particularly its use for nuclear and high-energy physics research, radiotherapy with negative pions, and radioisotope production. Also, the advantage of using negative pions for radiotherapy is discussed. (W.H.K.)

38810 (CEA-R-4153) EQUIPMENT DEVELOPMENT FOR MEASURING THE DENSITY DISTRIBUTION IN AN ELECTRON BEAM PRODUCED BY AN ELECTROSTATIC ACCELERATOR. MODIFICATION OF A 2-MV, 300-μA VAN DE GRAAFF GENERATOR TO PRODUCE A LARGE CROSS SECTION BEAM. Cortial, Henri (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar 1971. 91p. (In French). Dep. NTIS (U. S. Sales Only).

The principles and development of an electron beam analyzing apparatus are discussed (energies up to 2 MeV). The essential features are: radiative cooling, the lack of cooling fluid, an easily interchangeable electron capture assembly, which can be adapted to various types of measurement and a scanning speed which is variable over a large range. Beam localization with respect to the target and continuous quantitative analysis are simultaneously possible at any point in the beam. The development of an electron gun and the fundamental features of the prototype are discussed including absence of aberrations at the input; a controllable beam diameter; a current exceeding 30 mA; and a high yield without spraying from the extraction electrode. When this prototype is used with a 2 MeV, 300 μA Van de Graaff generator the exit diameter varies between 20 and 30 mm for a focusing voltage between 100 and 200 V. (auth) (France)

38811 (CERN-71-11) PHASE ACCEPTANCE OF AN ALTERNATING GRADIENT DOUBLET MADE OF QUADRUPOLES OF DIFFERENT APERTURES. Regenstrief, E. (European Organization for Nuclear Research, Geneva (Switzerland)). 4 May 1971. 55p. Dep. NTIS (U. S. Sales Only).

The phase space behavior of a quadrupole doublet is examined under more general conditions than in previous studies. The constraint of equal apertures of the quadrupoles making up the doublet has been lifted. It is shown that under these conditions the phase space contour in either the focusing–defocusing plane or in the defocusing–focusing plane may have ten different shapes. For each of them the phase acceptance area is evaluated. (W.H.K.)

38812 (CERN-Trans-71-3) PHASE MOTION OF THE HIGH INTENSITY BEAM OF THE STRONG-FOCUSING SERPUKHOV PROTON SYNCHROTRON. Pashkov, P. T.; Shukeilo, I. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov, Institut Fiziki Vysokikh Energii). Translated by O. Barbalat (CERN, Geneva, Switzerland), from report IFVE-SKU-70-15. 10p. Dep. NTIS (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 25: 25557. (W.H.K.)

38813 (JAERI-1205, pp 113-15) ACCELERATORS FOR THE STUDY OF PHOTONUCLEAR REACTIONS. Masuda, Masayoshi (Tokyo Inst. of Tech. (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

Betatrons, synchrotrons, and linear accelerators are widely used in photonuclear studies. Recently the requirements for monochromatic γ-rays have been increased. For this purpose, the existing machines are not fruitful. In any type of machine, two factors must be considered. One is output intensities and another is duty cycles. On the other hand, there are two ways to obtain monochromatic γ-rays, one is by an annihilation of positrons and another is the so called Illinois type. The linear accelerator has a strong output intensity but has a short beam burst, say, several microseconds in time. Therefore it is a very useful machine for monochromatic γ-rays by the method of positron annihilation. However, the obtained γ-rays by this method always have band structure in the energy spectrum, the energy spread being about 1 MeV. Therefore its application is extremely limited in the photonuclear experiment. The synchrotron is useful for the Illinois method because of its long X-ray burst, but the small amount of X-rays disturb its wide application for the same experiment. The properties of the FFAG betatron are spotlighted. The principle of FFAG was already established in 1955. Its application for photonuclear experiment has not yet been reported. The most fruitful machine for elucidating the giant resonance problem must be a 30 MeV FFAG betatron. The approximate specifications are given. (auth)

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38814 (KFK-1219) DEVELOPMENT OF A CRYOGENIC SYNCHROTRON MAGNET WITH HIGH PURITY ALUMINIUM COILS. Schauer, W.; Specking, W.; Turowski, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). May 1970. 11p. (CONF-700503-11). Dep. NTIS (U. S. Sales Only).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970).

Small iron magnets with aluminium exciting coils varying in purity have been tested at 4.2 K and 20.4 K in magnetic fields up to 30 kG. Resistivity ratio and magnetoresistance results are reported for pancakes wound from aluminium ribbon. At 4.2 K the relative resistivity increase $\Delta\rho/\rho$ due to the magnetoresistance tends to a saturation value of 1.5 at 30 kG, independent of the sample purity which is given by the pancake resistivity ratio in zero field and was measured to be 8000 for the best and 1500 for the worst material investigated. At 20.4 K, $\Delta\rho/\rho$ becomes purity dependent in contradiction to Kohler's rule and was found to be 3.6 for the best and 1.5 for the worst material at 30 kG. Questions concerning the appropriate conductor material and configuration, temperature of operation and cooling performance are discussed. (auth)

38815 (NP-18853) STUDY AND DEVELOPMENT OF AN ION DECELERATOR AND ITS APPLICATION TO COLLISION PROBLEMS. Do Cao, Guy (Lyon Univ. (France). Faculte des Sciences). 1970. 70p. (In French). Dep. NTIS (U. S. Sales Only). Thesis.

An attempt was made to obtain a sufficiently pure and conveniently focused ion beam for low-energy atomic collision studies. An apparatus was developed in which ions, initially accelerated by a few tens of kV, are decelerated by a reverse electrostatic field. This apparatus is small, with an independent setting, and adaptable to all SAMES 150 type accelerators. If the optical system is reversed, it can be used as a medium-power ion accelerator. The vibrational and rotational excitation of the N_2^+ $B^2\Sigma$ ion formed in collisions between slow ions and a molecular nitrogen target was studied. The large population in the upper vibrational and rotational levels of N_2^+ was established from heavy-ion collisions, particularly at a velocity of 10^7 cm/sec, which corresponds to the threshold excitation energy. These investigations may supply data useful in interpreting polar auroral spectra in which highly abnormal populating of the upper vibrational levels of proton-bombarded nitrogen occurs; this phenomenon may be due to secondary collisions with heavy ions. (France)

38816 (NP-18870) TRIUMF: ANNUAL REPORT, 1970. Brearley, N. (ed.) (TRI-Univ. Meson Facility, Vancouver (British Columbia). Apr 1971. 62p. Dep. NTIS (U. S. Sales Only).

Recent developments on construction, the TRIUMF experimental facility, cyclotron design and engineering, safety features, and the central-region cyclotron model are reported. In addition, information on project management and scheduling, organization and committees, conferences, reports and publications, staff, financial conditions, and users' groups is included. (R.W.R.)

38817 (RISO-M-1261) 10 MeV BREMSSTRAHLUNG CONVERTER. Hansen, Johnny (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr 1971. 15p. Dep. NTIS (U. S. Sales Only).

A 10 MeV 5 kW bremsstrahlung converter with a water cooled tungsten target for the production of x rays by stopping high-energy electrons from Risoe's 10 MeV linear accelerator is described. Calculations for the tungsten target are given. (W.H.K.)

38818 (UCRL-Trans-1442) RELATIVISTIC SOLITONS AND NONLINEAR WAVES AS BUNCHES FOR COHERENT ACCELERATION. Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Univ. of California Lawrence Radiation Lab., Berkeley, from report JINR-P9-5090. 14p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 47529. (W.H.K.)

38819 NEW FRONTIERS OF HIGH-ENERGY PHYSICS. Giacomelli, G. (CERN, Geneva. Univ., Bologna). pp 148-70 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

A brief description of the IHEP 76 GeV proton synchrotron is given, and high-energy physics research at the accelerator is discussed. Accelerator beams, particle production, and cross section measurements are described. Future perspectives for higher-energy elementary particle studies including the 400 GeV Batavia accelerator, the 300 GeV European accelerator, and the ADONE 1.5 GeV e^+e^- storage ring are discussed. (W.H.K.)

38820 DESIGN AND USE OF LARGE ELECTRON SYNCHROTRONS. Merrison, A. W. (Daresbury Nuclear Physics Lab., Eng.). pp 184-90 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

High-energy limitations of electron synchrotrons due to synchrotron radiation are considered and the maximum practicable energy of an electron synchrotron is discussed. Design proposals for a 15-GeV NINA booster are outlined, and possible experiments for a high-energy electron synchrotron are discussed. (W.H.K.)

38821 WAVE PROPAGATION AND TRANSIENT BEAM LOADING IN ALTERNATING PERIODIC STRUCTURES. Cornacchia, M. (Daresbury Nuclear Physics Lab., Eng.). Nucl. Instrum. Methods; 94: No. 1, 109-23(1971).

The exact response of biperiodic accelerating structures to transient excitations is derived. Numerical examples of the field build-up are given, and the effect of the second nearest neighbour coupling on the wave propagation and on the phase and amplitude stability during transients is investigated. A comparison is drawn of the performances of biperiodic structures and of monoperiodic structures operating in the π mode. The effect of transient beam loading is expressed in terms of a drive in each accelerating cell. Computations are carried out to assess the effect of the nonsynchronous modes on the beam during and after the beam has filled the structure. (auth)

38822 STUDY OF SECOND ORDER ABERRATIONS OF AN IONIC MICROANALYZER AND OTHER SYSTEMS INTENDED TO FILTER BROAD IMAGES. Leleyter, M.; Slodzian, G. (Univ., Amiens, France). Rev. Phys. Appl.; 6: No. 1, 65-89(Mar 1971). (In French).

Second order aberrations in broad images given by dispersive systems were geometrically calculated. The case of ion microanalyzers which are composed of a double homogeneous magnetic prism associated with an electrostatic mirror was especially studied. The most important second order aberrations are field astigmatism and chromatic aberrations. Minimum aberration was reached at a given position of the object. In the case of an ion microanalyzer, the overall aberration at that position was found to be about 0.3 μ at the edge of a 200 μ-field in the object space when the emission lens is apertured with a 400 μ-diaphragm which allows a resolving limit of 1 μ. (auth) (France)

38823 COMBINED FARADAY CUP AND BEAM STOP FOR AN EN TANDEM ACCELERATOR. Feldl, E. J. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods; 94: No. 1, 107-8(1971).

A Faraday cup which is also used as a beam stop has been constructed in the instrument shop of the Department of Physics, Kansas State University, and has been in use in the accelerator laboratory since August 1970. It is mounted just prior to the switching magnet and can be actuated from the control room of the tandem facility. The uniqueness of this unit lies in the fact that although ultra high vacuum techniques were employed, eliminating all organic materials, the use of long-stroke expensive metal bellows was avoided. (auth)

38824 SPECTROMETERS FOR PROTON DYNAMIC POLARIZATION IN A 50 kG FIELD. Odehnal, M.; Neel, P.; Bouffard, V.; Pasquette, C. (CEN, Saclay, France). Rev. Phys. Appl.; 6: No. 1, 59-63(Mar 1971). (In French).

A description is given of an apparatus for the dynamic polarization of protons in a field of 50 kG. The frequencies of the electron and nuclear paramagnetic resonance spectrometers are ~132 GHz and 202 MHz respectively. The magnetic field of 50 kG is created by a superconducting coil. The temperature of the sample is around 1°K. The results of the polarization of protons in ethyleneglycol suggest the construction of a similar apparatus for an operating polarized proton target which can give the same performances as the polarized targets now working at 25 kG and ~0.5°K. (auth) (France)

38825 IRRADIATION BY ACCELERATED ELECTRON BEAMS: INDUSTRIAL DOSIMETRIC CONTROLS. Icre, P. (Societe de Recherches Techniques et Industrielles, Orsay, France). Ind. At.; 15: No. 1, 17-24(Mar-Apr 1971). (In French).

The Corbeville Center for the Applications of Ionizing Radiations was set up in 1967. This Center is equipped with a linear electron accelerator, the Thomson-C.S.F.; its flexibility of operation and its power enable it to cope with the highly diversified demands encountered. Industrial utilization of an accelerated electron beam requires a perfect knowledge of the performance and the geometrical characteristics of the beam. Furthermore, numerous treatments such as radiosterilization necessitate sys-

tematic checks of the amount of radiation delivered to the irradiated products and materials. It is often necessary to predict and to determine the distribution of the dosage within the materials treated, when the treatment (for example radiochemical modifications of polymers) demands a well defined homogeneity. Three techniques of dosimetric control are used: isothermic calorimetry for measuring beam performances and the adjusting of the machine; adiabatic calorimetry for the control of the medium doses given to homogeneous products and the standardization of secondary dosimeters; and relative dosimetry by PVC films for determining the distribution of dosage, the geometry of the electron beam, and the control of minimum doses given in radiosterilization. (auth) (France)

38826 METHOD AND APPARATUS FOR INTERLEAVED CHARGED PARTICLE ACCELERATION. Westcott, Carl H. (to Atomic Energy of Canada Ltd.). U. S Patent 3,571,642. 23 Mar 1971. Filed 17 Jan 1968.

A method and apparatus for accelerating charged particles is described in which charged particles of opposite sign but of similar charge to mass ratio are accelerated through the same structure by means of an alternating electric field. The two sets of particles can be accommodated in the same apparatus by grouping particles of the same charge in bunches which are spaced by a phase difference of approximately π radians with respect to the accelerating field frequency from the bunches of the opposite charge sign. (auth)

38827 NEW STRUCTURE FOR AN ION ACCELERATOR. Pottier, Jacques (to Commissariat a l'Energie Atomique). French Patent 2,038,561. 28 Dec 1970. Filed 19 Mar 1969. (In French).

This addition concerns improvements in the application of increasing potentials to successive drift tubes and conforms with the main patent (2,038,562). The magnetic flux in the small straight half sections of the envelope is limited by the drift tube supports and decreases from the exit to the entry. (France)

38828 ION LINEAR ACCELERATOR. Pottier, Jacques (to Commissariat a l'Energie Atomique). French Patent 2,038,562. 28 Dec 1970. Filed 19 Mar 1969. (In French).

The invention concerns an efficient way of focusing ion beams in drift tube type accelerators. Elongated grids whose axes follow that of the beam are used. It is preferable that these grids consist of two half grids following two conic surfaces joined together by the bases of the cones. The grids are composed of ribbons whose edges are in the direction of the beam axis; such a configuration enhances their transparence to the ion beam. (France)

38829 SHORT PULSE ELECTRON GUN. Bensussan, Andre (to Thomson-CSF). French Patent 2,038,845. 28 Dec 1970. Filed 31 Mar 1969. (In French).

The invention concerns a pulsed electron gun for a particle accelerator which is characterized by a luminous source, an optical means of transmitting this light onto a layer of photoemissive material which produces an electron current, a means of amplifying this current and a means of extracting and using it. (France)

38830 GENERAL DESIGN FEATURES OF THE JINR 4 m ISOCHRONOUS CYCLOTRON WITH A SMOOTHLY VARIABLE HEAVY ION ENERGY. Shelaev, I. A.; Vorob'ev, E. D.; Zager, B. A.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 93: No. 3, 557-61(1971).

A 4 m isochronous cyclotron of JINR is being constructed for accelerating intense beams of heavy ions with A/Z ratio of 3.5 to 25 proton units and a smoothly variable energy within the range of 400 to 625 Z^2/A MeV. Basic physical parameters and ideas of this accelerator are presented. (auth)

38831 EXPERIMENTS ON FORMING, COMPRESSING, AND EXTRACTING ELECTRON RINGS FOR THE COLLECTIVE ACCELERATION OF IONS. Keefe, D.; Chupp, W. W.; Garren, A. A.; (and others) (Univ. of California, Berkeley). Nucl. Instrum. Methods; 93: No. 3, 541-56(1971).

In experiments related to the development of the electron-ring accelerator, electrons were injected into a pulsed magnetic field to form rings that were then compressed radially to a small size. The injected beam had a current of about 150 A at an energy of 3.3 MeV with an energy spread of ±0.1% and a pulse length duration of 20 nsec. At low intensity, an increase in the minor radius of the ring and a large loss of electrons were observed to occur during the compression cycle. At high intensity, cooperative phenomena that caused a large increase in the energy spread accompanied by particle loss were observed. Theoretical interpretation of these observations suggests that the primary source of electron loss and enlargement of the axial dimension was the crossing of single-particle resonances during compression in the presence of large magnetic field nonlinearities and perturbations. The cooperative phenomena are interpreted as resulting from a negative mass instability. Despite the large minor radius and small number of electrons, experiments on extracting the ring were performed; under acceleration the ring failed to retain its integrity because of inadequate self-focusing. (auth)

38832 ERROR ANALYSIS OF ν VALUE MEASUREMENTS AND AN APPLICATION. Month, M.; Gill, E. G.; Raka, E. C. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods; 93: No. 3, 535-9(1971).

By perturbing the closed orbit in an accelerator and comparing the shift in beam position with the theoretical expression for a dipole perturbation by a least squares procedure, an estimate of the average ν value of the beam is obtained. A statistical analysis of the experimental data is presented. This yields point estimates of the parameters (i.e., ν value, amplitudes and betatron phases) together with interval estimates and confidence levels. In this way, ν value measurements have been made at various times in the Alternating Gradient Synchrotron (AGS) cycle and at various average radii (i.e., momenta) in order to obtain the time dependent functional relationship between ν and radius, R. Assuming a linear relationship between ν and R, least squares fits and standard errors have been obtained for various times in the AGS cycle. Since the rate of change of ν with radius is very nearly proportional to the sextupole moment in each of the AGS magnets, estimates of the sextupole moment as a function of the field strength in the main ring magnets (i.e., time in the AGS cycle) have also been obtained. (auth)

38833 ULTRARELATIVISTIC PLASMA IN MAGNETIC FIELD. Ochelkov, Yu. P.; Rozental, I. L.; Shukalov, I. B. (Inst. of Cosmic Research, Moscow). Yadern. Fiz.; 13: No. 4, 804-9(Apr 1971). (In Russian).

Passage of relativistic electron beam of high intensity through a strong magnetic field is considered. For this problem collective interactions of the elementary particles are specific. The equations describing the passage of high energy electrons and photons in a strong magnetic field are given. The equations are solved in the simplest (homogeneous) case. The equilibrium conditions for the relativistic electron beam are considered. (auth)

38834 CALCULATION OF THE EFFECTIVITY OF A COAXIAL BUT NOT PARALLEL ARRANGEMENT OF CIRCULAR DETECTOR AND TARGET. Adomssent, S. (Univ., Rostock, Ger.). Isotopenpraxis; 6: 232-4(Jul 1970). (In German).

In experiments with strongly concentrated particle beams, a parallel arrangement of target and detector frequently becomes undesirable, and must be replaced by a coaxial setup. The mathematical formula is developed for such a setup. Computer programs for solving the integral are described. (H.B.G.)

38835 NEW BETATRON FOR MEDICAL PURPOSES. Gel'perin, B. B. Med. Radiol.; 15: No. 5, 46-8(May 1970). (In Russian).

A 25-MeV betatron which can provide both electrons and bremsstrahlung radiation for medical purposes is described. The heavy-metal targets for bremsstrahlung production are described, and a versatile beam bending and positioning system is described. (W.H.K.)

38836 ENERGY INDICATOR OF THE ELECTRON SYNCHROTRON. Fujii, Tadao; Imanishi, Akira; Kasuya, Masaaki; Yamakawa, Tatsuya (Tokyo Univ.). Jap. J. Appl. Phys., 10: No. 6, 774-80(Jun 1971).

A new method is developed for the precision indication of the energy of an electron synchrotron. The signal from a search coil placed inside the main magnet ($\propto dB/dt$) is integrated by a 1-MHz voltage-to-frequency converter, and its digital outputs are counted during the time interval between the zero field and the maximum field to give the precise value of B_0 at the central orbit. After being calibrated by standard pair spectroscopy, the device is capable of displaying the value of the endpoint energy of a bremsstrahlung beam with an accuracy of ±0.1 MeV for the energy range of 300 to 1200 MeV. (auth)

38837 STATUS OF THE LOS ALAMOS MESON FACTORY. Rosen, L. (Los Alamos Scientific Lab., N. Mex.). pp 469-91 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1-2, 1969. Quebec; Les Presses de l'Universite Laval (1970).

From Symposium on nuclear reaction mechanisms and polar-

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ization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

The construction of this most sophisticated high-intensity meson-producing facility is well underway. It is hoped that it will stimulate a renewed attack on the problems of nuclear structure, nuclear forms and the properties of pions, muons and neutrinos, from which will emerge a new level of understanding of the laws governing the atomic nucleus. Practical applications of the LAMPF beams are expected. (Canada)

38838 ION SOURCE HAVING A PLASMA AND GRIDLIKE ELECTRODE. Reifenschweiler, Otto (to Philips Corp.). U. S. Patent 3,569,756. 9 Mar 1971. Priority date 18 Aug 1964, Netherlands.

An ion source employing a plasma and a gridlike electrode forming part of the wall of a space in which ions are produced is described. The ions are accelerated by an accelerating electrode having an aperture the diameter of which is at least equal to half the diameter of the gridlike electrode; the resistance of the accelerating electrode to gas flow is so low that the pressure on each side is equal and so low that the ion flow is saturated. The gridlike electrode has an aperture of at least 1 mm in diameter through which electrons accelerated against the ion flow may be collected in the plasma space. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 37511, 37687, 38530, 38535, 38870, 38968, 39331, 39339, and 39340.

38839 (AERE-R-6622) SPECIFIC II. A MONTE CARLO PROGRAM FOR HIGH ENERGY NEUTRON SPECTRUM ESTIMATION. Holbrough, D. W.; Lipscombe, B. A. (Atomic Energy Research Establishment, Harwell (England)). Mar 1971. 44p. Dep. NTIS (U. S. Sales Only). UK 30p.

SPECIFIC II is a Monte-Carlo Code, written in IBM System/360 FORTRAN IV for estimating the high energy neutron spectrum resulting from either a fission source or a specified monoenergetic source in cylindrical (R,Z) geometry. It is possible to treat rods, that is, independent cylinders not centered on the origin. The code will accept problem data in free format. A prelude facility, similar to that available for the S2 compiler on the STRETCH computer, is incorporated whereby the demand for fast core is reduced to a minimum for problems of varying size and complexity. Estimates are made of the variances of the results, and options are available to integrate tabulated functions over the spectra produced and to present such spectra in a graphical form. (auth) (UK)

38840 (AERE-R-6658) COSMIC. A MONTE CARLO PROGRAM FOR THERMAL NEUTRON RE-THERMALISATION STUDIES. Carter, P.; Holbrough, D. (Atomic Energy Research Establishment, Harwell (England)). Mar 1971. 40p. Dep. NTIS (U. S. Sales Only). UK 27p.

Beams of re-thermalized neutrons from research reactors produced with the aid of "hot" and "cold" neutron sources are used for experimental studies in the fields of liquid and solid state research. To optimize the design of such sources a method was devised to overcome the problem of treating small moderator regions having complex geometry in which anisotropic scattering takes place, and which are subject to high flux gradients. This method has been embodied in the Monte Carlo program COSMIC described. The program, written in IBM system/360 Fortran IV, estimates the spectrum and associated errors of the neutron beam within and leaving the source block, described in cylindrical geometry with provision for a limited number of curved surfaces, for a specified incident thermal reactor spectrum. Details of problem input and the required nuclear data are given. A facility is described for allocating array space at program load time whereby a range of problems may be readily accommodated. (auth) (UK)

38841 (CEA-CONF-1755) RESEARCH OF A BIASING SYSTEM FOR THE CALCULATION OF THE DEEP PENETRATION OF NEUTRONS BY A MONTE CARLO METHOD. Lanore, J. M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 10p. (CONF-710302-12). Dep. NTIS (U. S. Sales Only).

From Meeting on new development in reactor mathematics and applications; Idaho Falls, Idaho (29 Mar 1971).

The deep penetration of neutrons in shielding materials is a problem difficult to solve with the Monte Carlo method because the variance increases with the distance from the source and becomes too high at long distances. A biasing system was studied to obtain a variance that does not depend on the distance. Two cases were considered: a homogeneous medium with constant cross sections and without inelastic scattering and a real homogeneous medium. The precision obtained is good. (France)

38842 (CONF-710302-3) SOME PROBLEMS ENCOUNTERED PROCESSING ENDF/B DATA WITH ETOG AND ETOP. Grimesey, R. A.; Singer, G. L. (Idaho Nuclear Corp., Idaho Falls). [1970]. 6p. Dep. NTIS.

From Meeting on new development in reactor mathematics and applications; Idaho Falls, Idaho (29 Mar 1971).

The program package ETOP, a variation of ETOG to fit the PHROG code theory, was used to process ENDF/B data files at Idaho Nuclear Corporation. Some of the problems encountered in this work are discussed. (R.W.R.)

38843 (DP-1250) CALCULATED ENHANCEMENT OF THERMAL NEUTRON FLUX FROM A ^{252}Cf SOURCE. McCrosson, F. J. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 1971. Contract AT(07-2)-1. 23p. Dep. NTIS.

The thermal neutron flux obtainable from a ^{252}Cf neutron source in a moderated subcritical multiplying system was studied by means of the ANISN code. The dependence of the flux on k_{eff} of the system, the Σ_{aeff} of the system, the ratio of fissionable material to purely absorbing material, and the type of moderating material are discussed. Two-group analytic solutions are presented to show the approximate dependence of the flux on the various parameters. Multiplying media and nonmultiplying media are compared. (auth)

38844 (ORNL-TM-3395) EXTENSION OF THE PROGRAM CHECKER. Lucius, J. L.; Wright, R. Q.; Penny, S. K. (Oak Ridge National Lab., Tenn.). 1 Jun 1971. 13p. Dep. NTIS.

The program CHECKER has been extended to process the ENDF/B version II photon production files 12-16. This work is supplemental to that already completed by the National Neutron Cross Section Center at Brookhaven National Laboratory. (auth)

38845 (UCRL-51031) SENSITIVITY OF MONTE CARLO CALCULATIONS TO THE NEUTRON CROSS SECTIONS FOR NEUTRON TRANSPORT IN NITROGEN AND IN AIR. Hansen, Luisa F.; Anderson, John D.; Kammerdiener, John L.; Wong, Calvin (California Univ., Livermore. Lawrence Radiation Lab.). 22 Mar 1971. Contract W-7405-eng-48. 24p. Dep. NTIS.

The predictions of the SORS Monte Carlo calculations for neutron transport from a 14-MeV neutron source in nitrogen and in air are compared using different libraries for nitrogen. In turn, these libraries are tested against experimental measurements for the integral neutron spectra between 0.5 and 10 mfp at 14 MeV. The measured neutron spectra cover a neutron energy range between 1 eV and 14 MeV. The neutron library for oxygen is checked against measurements for 0.72 mfp at 14 MeV for neutron energies between 30 keV and 14 MeV. It is found that features of neutron transport at 14 MeV are mainly determined by the neutron cross sections at neutron energies close to the source energy. This is especially so for neutron dose as a function of distance from the source. Neutron fluence as a function of neutron energy at a given distance from the source is, however, more sensitive to the neutron cross sections at energies below 14 MeV. This sensitivity is most pronounced at great distances from the neutron source. (auth)

38846 EFFECT OF ANISOTROPIC SCATTERING UPON THE ELASTIC MODERATION OF FAST NEUTRONS. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 44: 194-203(May 1971).

The effect of anisotropic elastic scattering upon neutron moderation has been investigated. Relations between the Legendre moments of the angular scattering data and the moderating parameters of the Greuling–Goertzel and improved theories are given, and it is shown theoretically and numerically that only the first few Legendre moments contribute significantly to the moderating parameters of the P_0 (lab) theory. In general, anisotropic scattering is shown to reduce dramatically the moderating effectiveness of a material, and to produce oscillations (in energy) in the neutron flux. Numerical examples for isotopes and mixtures representative of postulated fast breeder reactors are given to illustrate quantitatively the effect of anisotropic scattering. (auth)

38847 THERMAL NEUTRON BEAM INTENSITY GAIN FOR REFLECTING COLLIMATORS. Bandopadhyay, P. K. (Univ. of Rhode Island, Kingston). Nucl. Instrum. Methods; 94: No. 1, 125-30(1971).

An experimental confirmation of the gain in intensity due to reflecting collimators is described. Myristic acid and nickel were used to coat the collimator walls in order to obtain non-reflecting and reflecting properties respectively. The reflectivities of these substances were measured experimentally and an excellent agreement with theoretically predicted results was obtained. The intensity gain for collimators of dimensions: length 60", width $\frac{1}{4}$" and height $\frac{3}{4}$" was found to be 26%. (auth)

38848 DIFFUSION PARAMETERS OF THERMAL NEUTRONS IN SANTOWAX-R. Salmenhaara, S.; Sefidvash, F. (Technical Univ. of Helsinki, Otaniemi, Finland). J. Nucl. Energy; 25: 67-72(Feb 1971).

The diffusion parameters of Santowax-R were measured at the temperatures 170°, 200°, and 230°C using the pulsed neutron technique, and over a buckling range of 0.014–0.206 cm^{-2}. A Philips neutron generator was used to generate the neutron pulses. The decay constants of the neutrons were determined by means of a BF_3 counter operating with a 256-channel time-analyzer. The measured diffusion constants and diffusion cooling constants are in good agreement with the results of the scattering model developed for polyphenyls. (auth) (UK)

38849 MEASUREMENT OF COHERENT SCATTERING LENGTHS WITH CHRISTIANSEN FILTERS FOR NEUTRON

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BEAMS. Koester, L.; Knopf, K. (Technical Univ., Munich). Z. Naturforsch.; 26a: 391-9(Mar 1971). (In German).

By means of Christiansen filters it is possible to make use of the high accuracy achieved for the scattering amplitudes of liquids and also for solids in form of powders. The scattering law for the small-angle scattering of neutrons by Christiansen filters was investigated and good agreement between theory and experiment was found. Using powders of several elements, the scattering amplitudes of the elements with an uncertainty within ±0.2% to 1% could be measured. The results are for the bound atoms of Al : a = (3.449 ± 0.009) F; Cr : a = (3.532 ± 0.010) F; Sb : a = (5.641 ± 0.012) F; Si : a = (4.159 ± 0.006) F; Nb : a = (7.11 ± 0.04) F; Te : a = (5.43 ± 0.04) F and Ta : a = (6.91 ± 0.07) F. (auth)

38850 ABSOLUTE DETERMINATION OF THE COHERENT SCATTERING AMPLITUDE FOR SULFUR AND THE TOTAL REACTION CROSS SECTION FOR SUBTHERMAL NEUTRONS. Truestedt, W. D. (Technical Univ., Munich). Z. Naturforsch.; 26a: 400-4(Mar 1971). (In German).

The determination of the coherent scattering amplitude of bound S atoms, using the neutron gravity-refractometer of the Munich research reactor, resulted in the value a = 2.847 ± 0.001 F. The total cross section of liquid S (135 and 176°C) for neutron energies 4×10^{-3} to 0.15×10^{-3} eV was measured. The contribution of the self-diffusion of S to the inelastic scattering cross section was calculated. (tr-auth)

38851 CROSS SECTION FOR ULTRACOLD NEUTRONS. I. THEORY OF MAGNETIC SCATTERING. Binder, K. (Technical Univ., Munich). Z. Naturforsch.; 26a: 432-41(Mar 1971).

Very cold neutrons (typical wavelengths are about 10^2 Å) are available by recently developed techniques. The features of the scattering of these "ultracold" neutrons are investigated by discussing a few examples of magnetic scattering. The diffraction of neutrons by the vortex lattice in superconductors is treated as an example of elastic scattering, while in most other cases the scattering is inelastic. The scattering by ferromagnetic magnons at low temperatures and the critical scattering from an isotropic ferromagnet above the critical temperature are discussed. Simple models are used to derive the total cross sections. It is shown that relevant information about the inelasticity can be gained by the measurement of total cross sections in these cases. (auth)

38852 THICK TARGET YIELDS FOR THE $^{9}Be(\alpha,n)$ REACTION. Anderson, M. E.; Hertz, M. R. (Monsanto Research Corp., Miamisburg, Ohio). Nucl. Sci. Eng.; 44: No. 3, 437-9 (Jun 1971).

The thick-target yield for the reaction $^{9}Be(\alpha,n)$ at 5.3 MeV was obtained from measurements of sealed $^{210}Po-Be(\alpha,n)$ sources. The final result was 69 ± 2 neutrons/10^6 alpha particles. Published results on thin-target yields and stopping powers [Gibbons and Macklin, Phys. Rev., 137: B1508 (1965) and Bader et al., Phys. Rev., 103: 32 (1956)] were used to construct the thick-target yield curve from 3 to 10 MeV. (R.W.R.

38853 CROSS SECTION OF SLOW NEUTRONS ON PARAHYDROGEN. Houk, Theodore L. (Brookhaven National Lab., Upton, N. Y. Harvard Univ., Cambridge, Mass.); Shambroom, David; Wilson, Richard. Phys. Rev. Lett.; 26: No. 25, 1581-5(21 Jun 1971).

The total cross section for interaction of slow neutrons with parahydrogen was measured to 0.1%. A pressure dependence was found whose origin is obscure. By extrapolation to p = 0, a value for the coherent scattering length of $(-3.707 \pm 0.008) \times 10^{-13}$ cm is found, in agreement with the liquid-mirror result of $(-3.721 \pm 0.004) \times 10^{-13}$ cm. (auth)

38854 MOMENTS OF THE DISTRIBUTION FUNCTION OF NEUTRON DENSITY. Zima, T. E.; Kostritsa, A. A.; Neimotin, E. I. Izv. Akad. Nauk Kaz. SSR. Ser. Fiz.-Mat.; No. 6, 77-83(Nov-Dec 1970). (In Russian).

The Marshak method was utilized in calculating moments of the distribution function of neutron density where it was inconvenient to find a solution or if only the Fourier transform was the function desired. The moments of the distribution function are discussed for the one-velocity transfer equation with a scattering curve (indicatrix) of sufficiently general type and with anisotropic sources in an infinite medium. The analytic method is used to investigate neutron distribution in a moving medium of light nuclei, when the cross section is proportional to 1/V. (K.S.W.)

38855 STANDARD PHOTONEUTRON SOURCE AT THE ALL-UNION SCIENTIFIC-RESEARCH INSTITUTE OF METROLOGY. Fominykh, V. I.; Yaritsyna, I. A. Meas. Tech. (USSR) (Engl. Transl.); No. 11, 1755-9(Nov 1970).

Translated from Izmer. Tekh.; No. 11, 80-3(Nov 1970).

A detailed account is given of the precision measurement of the neutron flux of the Ra–Be (γ,n) standard source at the All-Union Scientific-Research Institute of Metrology. The result of the flux measurement was 2.90×10^5 neutrons/sec. (R.W.R.)

38856 ONE SPEED TRANSPORT THEORY SOLUTION FOR COMPLETE BACK SCATTERING. Ghatak, Ajoy K.; Singh, Om Pal (Indian Inst. of Tech., New Delhi). J. Nucl. Sci. Technol. (Tokyo); 8: No. 5, 287-9(May 1971).

Complete solutions of the one-speed neutron transport equation were obtained in the case of the neutron wave propagation problem in a finite medium for highly anisotropic backward peaked scattering. The particular case, corresponding to zero-source frequency (which is essentially a Milne problem) is also discussed in detail. Extrapolation distance for the Milne problem was calculated, and it was found that the extrapolation distance is independent of slab thickness. The results will be of use in calculating the diffusion coefficient for neutron energies corresponding to the first few Bragg peaks in a crystalline moderator. (M.H.R.)

38857 SLOWING DOWN AND HEATING UP OF NEUTRONS IN GRAPHITE AT LOW TEMPERATURES. Bhushan, Vidya (Safdarjang Hospital, New Delhi); Trikha, S. K. Nucl. Sci. Eng.; 44: No. 3, 444-7(Jun 1971).

Some results are reported of a theoretical study of the slowing down and heating up of neutrons in graphite at room temperature and some at lower temperature. An attempt is made to explain the great variation that exists in the different measured values of the neutron thermalization time in graphite at room temperature. (M.H.R.)

38858 EFFECT OF MODERATION ON REACTION CROSS-SECTION MEASUREMENTS. Levine, Melvin M. Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 44: No. 3, 372-5(Jun 1971).

A new method is presented for analyzing reaction-rate measurements to obtain cross sections. In the usual approach, a complete forward or slowing-down calculation is required for each beam energy at which the reaction rate is to be obtained. The approach here uses an adjoint formulation, yielding reaction rate vs energy in a single pass; the analysis is thus easier to perform, and the physical process is more transparent. The accuracy of the approximations involved in the present approach is tested in two cases by comparison with rigorous Monte Carlo results. For certain conditions of sample thickness and cross section as shown in this paper, the usual trial-and-error procedure for finding cross sections that fit the measured reaction rates can be avoided. It is then possible to invert the reaction rates directly into cross sections. A test case is described in which this direct inversion process proved to be stable and accurate. (auth)

38859 ^{252}Cf NEUTRON SOURCES FOR INDUSTRIAL APPLICATIONS. Boulogne, A. R.; Faraci, J. P. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Technol.; 11: No. 1, 75-83(May 1971).

Californium-252 makes an intense neutron point source which emits 2.34×10^{12} neutrons per second per gram through spontaneous fission. Sources are being prepared to investigate the value of this radionuclide for mineral, petroleum, and gas explorations, well logging and hydrology, activation analysis, neutron radiography, and other areas where isotopic neutron sources are used. Sources with active volumes of less than 25 mm^3, containing milligram amounts of ^{252}Cf, are being prepared by precipitating and filtering californium oxalate on a small metallic filter, which is in the primary capsule, in a totally enclosed apparatus. The oxalate is calcinated to $^{252}Cf_2O_3$ before the primary capsule is sealed. These sources are doubly encapsulated under conservative design criteria to prevent leakage of radioactive material because they are used in a wide variety of environmental conditions. The neutron emission rate of the finished sources is within 10% of the desired value. Less than 1% of the ^{252}Cf was lost in the process. Because the practical upper limit for the present capsule design is about 10 milligrams of ^{252}Cf, procedures are being developed for preparing sources containing up to several hundreds of milligrams of the isotope. (auth)

38860 EXPOSITORY DERIVATION OF NEUTRON TRANSPORT EQUATIONS. Harms, A. A. (McMaster Univ., Hamilton, Ont.); Schreiner, S. I. Nucl. Technol.; 11: No. 1, 144-9(May 1971).

An expository formalism concerning the derivation of various forms of neutron transport equations is discussed. It relies fundamentally on a general neutron conservation condition as the starting point. The basic concepts employed are (1) expected number of neutrons, (2) phase-space representation, and (3) neutron density function. Thereafter, application of the formalism involves only common mathematical operations and some understanding of neutron-nucleus interactions. (auth)

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Refer also to abstracts 37644, 38640, 38641, 38676, 38888, 38972, 38988, 39056, 39058, 39118, and 39123.

38861 (ITF-71-1-E) CORRELATION EFFECT IN ^{4}He AND ^{16}O. Maksimenko, V. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 37p. Dep. NTIS (U. S. Sales Only).

The second-order corrections of the perturbation theory to the variational calculation of binding energies and dimensions of ^{4}He and ^{16}O carried out with the oscillator wave functions of the shell model are considered. The wave function of the shell model defines more exactly the average values of one-particle operators (kinetic energy, root-mean-square radius) and with less accuracy the two-particle operators (potential energy of the pair forces). A variational calculation within the frameworks of the shell model gives a satisfactory approximation in the case of ^{4}He. When calculating the binding energy of the systems like ^{16}O it is obviously necessary to take into account the configuration mixing. For the pair exchange forces providing for saturation, mixing of the upper configurations in the wave functions of ^{16}O is of the order of 50%. This result allows one to understand why calculations of the binding energy of atomic nuclei within the shell model do not lead to satisfactory results. (auth)

38862 (JAERI-1205, pp 36-7) EXCITED STATES IN ^{4}He. Sanada, Junpei; Seki, Seiji (Tokyo Univ. of Education (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

Proton spectra from the ^{4}He(γ,p)^{3}H reaction with 32 MeV bremsstrahlung X-rays were measured at 45°, 90°, and 135° lab angles. Two broad peaks were found at 24 and 27 MeV, and a local minimum at 26 MeV in the excitation function. The $\sin^2\theta$ angular distribution at the two peaks suggests that the reaction proceeds mainly through E1 absorption. An analysis of the data in terms of two non-interfering resonances shows that the lower 1^- T = 1 state at 25 MeV in ^{4}He is mainly a $^1P_1$ configuration. (auth)

38863 (ORO-4043-2) PROGRESS REPORT [ON EXPERIMENTS ON NUCLEAR INTERACTIONS OF PIONS]. McCarthy, J. S.; Minehart, R. C.; Sobottka, S. E.; Ziock, K. O. H. (Virginia Univ., Charlottesville). May 1971. Contract AT(40-1)-4043. 10p. Dep. NTIS.

Data gathering on pion scattering from ^{16}O is now completed, and the data are being analyzed. An experiment to measure the yields and angular distributions in the (π^-,np), (π^-,nd) and (π^-,nt) reactions in ^{16}O was successfully carried out, and data will be analyzed during the coming year. The (π^+,2p) and (π^+,p) experiments performed at Berkeley are now in the data analysis phase. Measurements on the muon kinetic energy in π^+ decay were completed and the data are being analyzed to obtain a better upper limit on the muon neutrino rest mass. Work is proceeding on a liquid He target for studies of π^- capture in ^{4}He. A collaboration with LAMPF is carried out on the design of the magnetic spectrometer and detector system for EPICS, the high resolution pion scattering facility. The EPICS Working Group is participating in the development of beam monitoring equipment, computer programming and detector design. A list of published papers is included. (auth)

38864 THREE-BODY BREAKUP IN DEUTERON-PROTON SCATTERING. Schilling III, Ralph Franklin. College Station, Tex.; Texas A and M Univ. (1970). 135p. University Microfilms Order No. 71-8910.

Thesis.

The reaction ^{1}H(d,2p)n was studied in a kinematically complete experiment at a deuteron bombarding energy of 57.96 MeV. A system of 59 plastic scintillator detectors was used to take proton-proton coincidence data simultaneously at 208 pairs of angles in the laboratory coordinate system. An IBM 7094 digital computer was used on-line for simultaneous data acquisition and live-time diagnostic checking of the operation of the experimental apparatus. The data were transformed to the center-of-momentum coordinate system, and are displayed as a function of the energies of the product nucleons by means of a Dalitz plot. A tabulation of the differential cross section as a function of the energies of the two protons is also included. (auth) (Diss. Abstr. Int., B)

38865 NEUTRON-NEUTRON QUASIFREE SCATTERING. Slaus, Ivo (Univ. of California, Los Angeles); Sunier, J. W.; Thompson, G.; (and others). Phys. Rev. Lett.; 26: 789-92 (29 Mar 1971).

The reaction D(n,2n)P was measured at E_{inc} = 14.1 MeV, $\theta_{n(3)} = \theta_{n(4)} = 30°$, $\varphi = 180°$, and the results are compared with the predictions of two separable-potential models. Neutron-proton and proton-proton quasi-free scattering from nucleon + deuteron reactions at 14 MeV are also compared with the predictions of the same models. The upper limit of 2 mb/sr^2 is determined for the reaction D(n,nγ)D. (auth)

38866 EVIDENCE FOR NEUTRON EXCHANGE IN THE ^{3}He-^{4}He ELASTIC SCATTERING AT MEDIUM ENERGIES. Fetscher, W. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.); Seibt, E.; Weddigen, Ch.; Kannellopoulos, E. J. Phys. Lett.; 35B: 31-2(26 Apr 1971).

The differential cross section was measured for 66 to 103 MeV ^{4}He elastic scattering on ^{3}He(E_{CM} = 28 to 44 MeV). The experimental values are compared with results of cluster model calculations in the one-channel approximation. Theoretical and experimental results agree qualitatively with respect to angular and energy dependence. The observed backward peaking is attributed to neutron exchange which is practically independent of spin-orbit effects. (auth)

38867 CONVERGENCE OF THE HYPERSPHERICAL FORMALISM APPLIED TO THE TRINUCLEONS. Beiner, M.; Fabre de la Ripelle, M. (Institut de Physique Nucleaire, Orsay, France. Lett. Nuovo Cim.; 1: No. 14, 584-9(3 Apr 1971).

An approach to the many body problem is described in which the fundamental equations are derived from an expansion of the two-body interaction and of the wave function on a complete basis of angular eigenfunctions at the surface of a hypersphere whose dimensions are the number of free variables. The hyperspherical formalism thus transforms the Schroedinger partial differential equation into an infinite set of coupled differential equations. This formalism is applied to the trinucleon by using two-body interactions that are superpositions of Gaussian central potentials. The main features of the hyperspherical formalism are summarized. The triton binding energy obtained at various iterations by integrating the coupled equations is tabulated. It is found that neglect of the contribution to the binding energy arising for the mixed-symmetry part of the wave function is not justified. The formalism is an especially powerful tool for dealing with light nuclei. (R.W.R.)

38868 $\frac{1}{2}^+$ STATE OF ^{3}H AND ^{3}He BELOW THE BREAK-UP THRESHOLD. I. HAMADA-JOHNSTON POTENTIAL. Delves, L. M.; Hennell, M. A. (Univ. of Liverpool). Nucl. Phys.; A168: No. 2, 347-84(1971).

A series of accurate calculations on the $J^\pi = \frac{1}{2}^+$ state of ^{3}H and ^{3}He with the Hamada-Johnston potential below the threshold for break-up are described. Quantities calculated for the bound states include the binding energy, percentages of various angular states, charge and mass radii, electric form factors, and Coulomb energies for both point and extended protons. The charge form factors show a typical diffraction minimum at a momentum transfer of around 12.6 fm^{-2}, in rather good agreement with the recent experimental values of McCarthy et al. For n-d elastic scattering the complete (2 × 2) scattering matrix up to a c.m. energy of 4 MeV is computed. To test the sensitivity of the results to the interaction used, the effects of an additional three-body potential and of a change in the strength of the potential component $^1V_c^+$ are also investigated. When either of these additional terms is adjusted to fit the triton energy E(^{3}H), reasonable overall agreement with experiment is obtained for those parameters, such as the charge radius, which are expected to depend chiefly on the overall size of the triton and not on its detailed structure. Discrepancies remain in the doublet scattering length, and particularly in the Coulomb energy E_c; moreover, the diffraction minimum in the form factors moves to 14 fm^{-2}, in poorer agreement with experiment. It remains a moot point whether an alternative fit to the two-body data would remove the discrepancy in these parameters; the results appear to give some support for a potential containing a softer but larger radius core than that of the HJ potential. (auth)

38869 TWO-PARTICLE (γ,n) PHOTODISINTEGRATION OF THE TRITON. Rahman, M. (Atomic Energy Centre, Dacca, Pakistan); Sen Gupta, H. M.; Husain, D. Nucl. Phys.; A168: No. 2, 314-20(1971).

The two-particle (γ,n) photodisintegration of the triton is studied using a modified Irving wave function for the triton and including the final-state interaction. The parameters of the triton wave function are given by the variational calculations of the binding energy of the system using a central velocity-dependent potential, and those of the n-d interaction are obtained from the p-wave scattering phase shifts. The n-d interaction is found to be im-

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portant and it is possible to obtain a satisfactory agreement to the observed energy variation of the photodisintegration cross section. (auth)

38870 INTENSITY PROFILE OF A NEUTRON BEAM DETERMINED BY THE ASSOCIATED α-PARTICLES IN THE REACTION T(d,n)^{4}He AT DEUTERON ENERGIES AROUND 200 keV. Tagesen, S.; Nowotny, R. (Institut fuer Radiumforschung und Kernphysik, Vienna). Nucl. Instrum. Methods; 93: No. 3, 581-3(1971).

Calculations and detailed measurements on the intensity distribution in a neutron beam, determined by the associated particle method, have been performed. In the calculations small-angle scattering and reaction kinematics have been considered. Small-angle scattering generates a distribution with fwhm of 1.75° at 220 keV deuteron energy and a target thickness of 550 $\mu g/cm^2$. Besides this, only influences caused by reaction kinematics are significant. (auth)

38871 HARTREE–FOCK CALCULATION FOR ^{4}He IN A NONORTHOGONAL BASIS. Iosifescu, M.; Scutaru, H. (Inst. for Atomic Physics, Bucharest). Lett. Nuovo Cim.; 1: No. 20, 817-22(15 May 1971).

The results of Hartree–Fock calculations in a harmonic-oscillator basis have been shown to be very sensitive to the dimension of the basis. In the hope of decreasing the dimension of the HF equations required, a nonorthogonal basis is chosen; in order to test its adequacy, the binding energy, rms radius, and body form factor of ^{4}He are calculated. Tables of convergence and stability are given for various potentials. It is found that a HF wave function is inadequate to fit the body form factor and give simultaneously the best binding energy: one way to correct the wave functions is the introduction of short-range correlations. (R.W.R.)

38872 OBSERVATION OF A T = ½ RESONANCE IN ^{3}He BY INELASTIC α-PARTICLE SCATTERING. Halbert, M. L.; van der Woude, A. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 26: 1124-6(3 May 1971).

A T = ½ resonance in ^{3}He was observed in the inelastic scattering of 63.7-MeV α particles by ^{3}He. The resonance is centered at 20.4 ± 0.3 MeV excitation and has a width of 3.4 ± 0.4 MeV. (auth)

38873 ELECTROMAGNETIC AND WEAK FORM FACTORS OF ^{3}He AND ^{3}H. Akhmadkhodzhaev, B.; Belyaev, V. B.; Vzhetsionko, E.; (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol.; B1: 409-14(Oct-Dec 1970). (In Russian).

The Faddeev equations for the bound-state problem are solved using two realistic local nucleon–nucleon potentials that describe the scattering phases in a wide range of energies. The electromagnetic form factors of ^{3}He and ^{3}H are calculated, as well as the matrix elements $|\int\vec{\sigma}|^2$ and $|\int 1|^2$ determining beta decay of tritium and muon capture by ^{3}He. From experiments on μ^- capture the value of the pseudoscalar constant g_P is determined. (tr-auth)

38874 REACTIONS WITH POLARIZED DEUTERONS ON LIGHT ELEMENTS. Huber, P. (Univ., Basel). pp 287-311 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

The technique for producing a beam of polarized deuterons is reviewed briefly. Measurements made at the University of Basel of the analyzing powers of (d,p) and (d,n) reactions involving D, ^{6}Li, ^{3}He and ^{3}H targets and of the ^{6}Li(d,α) reaction are discussed. Results for the D(d,p)T and D(d,n)^{3}He reactions with deuteron energies in the range 150 to 460 keV indicate that the assumptions in present theories are too limiting. A review of experiments at the Federal Institute of Technology (Zurich) on d–^{4}He elastic scattering with vector-polarized deuterons (3 to 11.5 MeV) indicates that the elastic scattering of deuterons by ^{4}He is a useful analyzer for deuteron vector polarization at most energies in the range considered. (Canada)

38875 WORK WITH POLARIZED TRITONS AT LOS ALAMOS. Keaton, P. W. Jr. (Los Alamos Scientific Lab., N. Mex.). pp 331-50 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

Basic double-scattering techniques used to measure absolute polarization values are presented. It was found that a one-picoampere beam of tritons was elastically scattered from ^{4}He with a polarization of 84%. Also, a 0.5-picoampere beam of ^{3}He was elastically scattered from ^{4}He with a polarization of 64%. Several applications with polarized tritons and ^{3}He, including a number of few-nucleon problems, a direct reaction involving pickup, and an attempt to measure the strength of the triton spin–orbit term in a triton optical potential for intermediate-weight nuclei, are described. (Canada)

38876 INTERACTION OF INTERMEDIATE ENERGY PROTONS WITH LIGHT NUCLEI. Boschitz, E. T. (Lewis Research Center, Cleveland). pp 437-68 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

Elastic and inelastic scattering of 600-MeV protons by light nuclei is discussed. The eikonal and the multiple-scattering approximations are used to fit the elastic scattering data. (p,2p) experiments on D and ^{4}He are analyzed in Born approximation to gain information about the Fermi distribution of nucleons in the nucleus. Finally, data for the reaction (p,pd) on light nuclei are given. (Canada)

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Refer also to abstracts 37588, 38640, 38852, 38861, 38863, 38874, 38876, 38918, 38923, 38925, 38934, 38941, 38943, 38962, 38963, 38972, 38988, 39043, 39049, 39056–39058, 39073, 39074, 39088, 39089, 39104, 39108, 39117, and 39123.

38877 (INP–735) MODELS OF THE ELASTIC SCATTERING OF ALPHA PARTICLES. Makowska-Rzeszutko, M.; Dudek, A.; Drzymala, A. (Institute of Nuclear Physics, Krakow (Poland)). Dec 1970. 60p. Dep. NTIS (U. S. Sales Only).

An analysis was carried out of the elastic scattering of 25 MeV alpha particles measured for 24 elements. Experimental angular distributions were reproduced by the Frahn–Venter model, Springer–Harvey models, and the optical model. The models were compared and the angular range applicable for each model and the reproducibility of the σ_R values were examined. For the strong absorption models, the energy dependence of parameters was observed and ambiguity of models was found. Geometrical parameters of nuclei were calculated and listed along with results of another author. (auth)

38878 (JAERI–1205) STUDY OF NUCLEAR PHYSICS WITH LINAC. Conference Held at Tokai Research Establishment, February 19–21, 1970. Shikazono, Naomoto; Nakajima, Yutaka (eds.) (Japan Atomic Energy Research Inst., Tokyo). Mar 1971. 119p. (In Japanese). (CONF-700223). Dep. NTIS (U. S. Sales Only).

Separate abstracts were prepared for 21 of the 27 papers included. The remaining 6 papers contained only lists of specifications for several Japanese accelerators. (J.W.R.)

For abstracts of individual papers see: 38813, 38862, 38879–38887, 38923, 38924, 38982–38984, and 39064–39068.

38879 (JAERI–1205, pp 12-16) PYGMY RESONANCE IN THE REACTION ^{13}C(γ,n)^{12}C. Fukuda, Kyue (Radiation Center of Osaka Prefecture, Osaka (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

The cross section for the reaction ^{13}C(γ,n)^{12}C was measured at photon energies up to 14 MeV by using bremsstrahlung from a 15-MeV linear electron accelerator. The neutron yield was measured as a function of the maximum energy of bremsstrahlung energy from threshold to 14.5 MeV. The cross section for the ^{13}C(γ,n)^{12}C reaction is obtained by using the inverted matrix method of Penfold and Leiss. The photoneutron cross section curve for ^{13}C shows maxima at 6.2, 7.5, 8.2, 9.1, 11, and 13 MeV, the last two being in the pygmy resonance energy region. The integrated cross sections from threshold to 10 MeV and to 14 MeV are 2 and 16 MeV · mb, respectively. Angular distributions of photoneutrons were measured for the incident bremsstrahlung with different values of $E_{\gamma max}$. They are analyzed for the distribution of the neutrons corresponding to each peak. The angular distribution of the neutrons in the pygmy resonance region is $1 + 0.46 \sin^2\theta$. The results are compared with the theoretical ones reported by several authors. The photoneutron cross section curve for ^{13}C is compared with those of ^{9}Be and ^{28}Si in the subgiant resonance energy region. The cross section curves of these nuclei are interpreted in terms of the mixing of core excitations and valence nucleon excitations. (auth)

38880 (JAERI–1205, pp 17-21) ISOTOPIC SPIN MIXING IN THE GIANT DIPOLE RESONANCE. Mutsuro, Naoshi (Niigata Univ. (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

The characteristics of isotopic spin mixing in the giant dipole resonance are briefly reviewed. The $^{12}C(\gamma,\alpha_0)$ reaction was used to study gross features of isotopic spin mixing in the E1 giant resonance, and the dipole resonance of the reaction was found to invoke isospin splitting and the major T = 0 strength placed below the T = 1 strength in energy. The isospin population in the giant resonance of ^{31}P was studied through the high resolution (γ,n) spectrum obtained by the T–O–F technique, and it was found that the giant resonance of ^{31}P was constructed mainly at the T = $\frac{3}{2}$ states. (auth)

38881 (JAERI–1205, pp 38-40) LOW-LYING STATES IN ^{9}Be. Sanada, Junpei; Seki, Seiji (Tokyo Univ. of Education (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

Experimental evidence on the level scheme of ^{9}Be and ^{9}B thus far obtained is discussed. An interpretation which implys that the low-lying states are composed of normal parity states is presented. Recent experiments show that the missing $\frac{1}{2}^-$ state is established at 3.03 MeV. (auth)

38882 (JAERI–1205, pp 41-3) COMMENT ON NUCLEAR PHOTOEFFECT. Fujita, Jun-ichi (Tokyo Univ. (Japan). Inst. for Nuclear Study). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

Recently it was pointed out by J. Sanada that the 1.7 MeV peak of the excitation function for $^{9}Be(\gamma,n)^{8}Be$ reaction should not be interpreted as a real resonance state of ^{9}Be. The purpose of this short note is to reexamine the above problem from a little more general viewpoint. Possible test experiments are discussed. (auth)

38883 (JAERI–1205, pp 44-8) α DECAY FROM SOME EXCITED STATES OF ^{12}C ABOVE THE PROTON THRESHOLD. Yamane, Isao; Takimoto, Kiyohiko; Muto, Jiro (Kyoto Univ. (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

The dependence of coincident α energy spectra on the incident proton energy was measured for the reaction $^{11}B(p,3\alpha)$, over E_p = 150 keV ~ 235 keV and E_p = 2.0 MeV ~ 5.30 MeV. Shapes of spectra show strong dependence on E_p and furthermore on the levels of ^{12}C, when the detection condition is so selected that the peak of α_I should be sufficiently separated from the peak of α_{II}, assuming the sequential decay mechanism. At E_p = 163 keV and 2.62 MeV resonances, spectra show a broad peak with a flat top that agrees with the shape of the phase space volume. At the 4.93 MeV resonance and E_p = 215 keV, spectra show two peaks of α_I and α_{II} were kinematically expected from the sequential decay mechanism. The former is considered to indicate the direct three α break up and the latter the sequential decay. Those states which decay directly to three α's and have a large α reduced width are considered to have the three-α-cluster structure. (auth)

38884 (JAERI–1205, pp 49-51) STRUCTURE OF THE 1st EXCITED 0^+ STATE OF ^{16}O. Suekane, Shota; Yura, Tadayoshi (Osaka City Univ. (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

It is shown that the spherical 0p–0h ground state and the deformed 4p–4h excited state of ^{16}O have minimum Hartree–Fock energies for different values of the oscillator length b and that b(4p–4h) > b(0p–0h). This result may be caused partly from the finiteness of the size of the nucleus and may make it possible to predict consistently without adjustable parameters the location of the 1st excited 0^+ state, B(E2) values among the low-lying states, and the monopole matrix element. (auth)

38885 (JAERI–1205, pp 71-7) INELASTIC ELECTRON SCATTERING FROM LIGHT NUCLEI. Nakahara, Kazuo (Tohoku Univ., Sendai (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

Using the 300 MeV electron linac of Tohoku University, electron scattering experiments were performed in the energy range 70–250 MeV at angles between 35 and 135 degrees. Experimental form factors for excited states in ^{9}Be, ^{12}C, ^{16}O and ^{20}Ne are reported. (auth)

38886 (JAERI–1205, pp 78-80) STUDY OF THE STRUCTURE OF ^{6}Li WITH ELECTRON SCATTERING. Suzuki, Toshio (Tohoku Univ., Sendai (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

The nuclear structure of ^{6}Li is discussed in connection with the form factor for the transition to 3.56 MeV level and the cluster-character of ^{6}Li is interpreted in connection with a shell model. (auth)

38887 (JAERI–1205, pp 87-90) PARTICLE REACTIONS ASSOCIATED WITH PHOTONUCLEAR REACTIONS ON LIGHT NUCLEI. Oda, Yukiyasu (Tokyo Inst. of Tech. (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

Two reports are presented independently for the $^{14}N(p,p')$ and the (p,γ), (p,γ_0) and $(p,p'\gamma_1)$ reactions on ^{28}Mg with intimate relations to respective photonuclear reactions. Firstly, the angular distributions of the product protons from the $^{14}N(p,p'_n)^{14}N^*$ reactions with n = 1 to 12 were studied at the seven points of proton energies where Hanna has recently observed resonances in the $^{14}N(p,\gamma_0)^{15}O$ reactions. Corresponding features of both results are mentioned briefly. Secondly, concerning the $^{27}Al(\gamma,p)^{26}Mg$ reactions (Q = –8.272 MeV), the results of experiments performed in this laboratory in series and that reported by other authors in literature show the existences about twenty resonance levels in the excitation energy region $E_X \leq 21$ MeV of ^{27}Al. The excitation function of the $^{26}Mg(p,\gamma)$, $^{26}Mg(p,\gamma_0)$ and $^{26}Mg(p,p'\gamma_1)$ reactions studied recently in energy step 2 keV with HIVEC 4 MV Van de Graaff accelerator for the region $2.684 \leq E_p \leq 3.174$ MeV are reported briefly. Resonances are found most eminently at E_X = 10.927 MeV for the (p,γ_0) reactions and at 11.102 MeV for the $(p,p'\gamma_1)$ reactions. (auth)

38888 (LNF–70/57) ELECTRON SCATTERING ON NUCLEI: A BRIEF REVIEW. Isabelle, D. B. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Dec 1970. 13p. (CONF-701121–3). Dep. NTIS (U. S. Sales Only).

From Meeting on electronsynchrotron; Frascati, Italy (5 Nov 1970).

Typical spectra of scattered electrons can be divided into regions of elastic scattering, inelastic scattering, quasi-elastic scattering, and quasi-inelastic scattering. Typical experimental arrangements are described, and the expression for the electron-scattering cross section is presented. The kinds of information that may be obtained from electron scattering are discussed, and methods for dealing with radiative corrections are presented. Sample spectra from electron inelastic scattering by ^{48}Ti at 96 MeV are given, as well as elastic form factors for ^{10}B and ^{11}B. (R.W.R.)

38889 (NP–18862) STUDY OF THE REACTIONS $(^{3}He,p)$ WITH ^{11}B, ^{14}N, AND ^{20}Ne, AND THE EXCITED LEVELS OF ^{21}Na AND ^{41}Ar FROM THE $^{20}Ne(p,\gamma)$ AND $^{40}Ar(d,p\gamma)$ REACTIONS. Meynadier, Christian (Lyon Univ. (France). Faculte des Sciences). 1970. 159p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A 3 MeV Van de Graaff accelerator was used in studying the $(^{3}He,p)$ reactions with ^{20}Ne, ^{14}N, and ^{11}B nuclei and the γ de-excitation of ^{21}Na, and ^{41}Ar. The apparatus used and the techniques developed (reaction chamber, gaseous targets, detection systems) are described. The investigations demonstrated the predominance of compound nucleus mechanisms in the ^{20}Ne, and $^{11}B(^{3}He,p)$ reactions. The Hauser–Feshbach theory predicts quite well the total experimental cross sections of the different groups in these reactions. In the $^{14}N(^{3}He,p)$ reaction the direct interaction mechanism is dominant. An analysis using the DWBA method of the $^{20}N(^{3}He,p_{14})$ reaction led to the assigning of 1^+ characteristics to the E = 3.944 MeV level of ^{22}Na. The de-excitation γ radiation from the E = 4.14 MeV ^{22}Na level was established. Analysis of p,γ correlations in the $^{40}Ar(d,p\gamma)^{41}Ar$ reaction confirmed the spin $\frac{1}{2}$ of the 2.398 MeV state of ^{41}A and established a spin of $\frac{3}{2}$ for the 2.734 state of this nucleus. (France)

38890 STRIPPING REACTIONS AND ELASTIC SCATTERING OF 12 MeV VECTOR POLARIZED DEUTERONS ON ^{9}Be AND ^{12}C. Griffith, J. A. R.; Irshad, M.; Karban, O.; Oh, S. W.; Roman, S. (Univ. of Birmingham, Eng.). Nucl. Phys.; A167: 87-96(1971).

Angular distributions were obtained of the vector analyzing

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power for ^{9}Be(d,d), ^{12}C(d,d), ^{9}Be(d,p)^{10}Be, and ^{12}C(d,p)^{13}C reactions induced by 12-MeV polarized deuterons. Most features of the (d,p) reactions are adequately accounted for by DWBA calculations with optical-model deuteron potentials that describe the elastic scattering at the same energy. The calculations distinctly favor real central deuteron potentials around 100 MeV. (auth)

38891 DIRECT REACTION MECHANISM IN THE ^{11}B(p,α) REACTION. Cavaignac, J. F. (Institut des Sciences Nucleaires, Grenoble, France); Longequeue, N.; Honda, T. Nucl. Phys.; A167: 207-15(1971).

Absolute differential cross sections for the ^{11}B(p,α) reaction leading to the ground state of ^{8}Be were measured at E_p = 12, 20, 24, and 30 MeV. These results and previous results at E_p = 26.7 and 38 MeV are compared with PWBA calculations, with direct mechanisms and their interference term taken into account. Two possibilities investigated: firstly, pick-up and heavy-particle pick-up; secondly, knock-out and heavy-particle pick-up. Both possibilities agree well with experimental results. (auth)

38892 π-CARBON INELASTIC SCATTERING NEAR THE 33 RESONANCE. Edwards, G. W.; Rost, E. (Univ. of Colorado, Boulder). Phys. Rev. Lett.; 26: 785-8(29 Mar 1971).

Inelastic π^- – C scattering from 120 to 280 MeV is calculated in the distorted-wave Born approximation by using the Kisslinger optical potential and treating the 2^+ (4.44-MeV) and 3^- (9.64-MeV) levels as rotational states. Agreement with experimental data is good, especially in the forward hemisphere. Fairly consistent values for the deformation parameters are obtained. (auth)

38893 BETA DECAY OF ^{19}O TO THE 1/2$^-$ STATE OF ^{19}F. Cooper, John Charles. Eugene; Oreg.; Univ. of Oregon (1970). 62p. University Microfilms Order No. 71-10,708.

Thesis.

The intensity of the unique first-forbidden 4.708-MeV outer branch of the ^{19}O β spectrum, leading to the 110-keV, $\frac{1}{2}^-$ hole state in ^{19}F, was determined as $(4.8^{+1.3}_{-1.2}) \times 10^{-4}$ per day ^{19}O decay. Consequently, the comparative half-life is $f_1t = (1.5^{+0.4}_{-0.3}) \times 10^{10}$ sec, and the strength of the transition is $\langle G_1 \rangle^2 = 0.13^{+0.03}_{-0.03}$ F^2. This result was found from the analysis of $\beta-\gamma$ coincidence spectra obtained from reactor-irradiated water samples that had been enriched in ^{18}O. An upper limit of 6×10^{-4} is set on the branching of the 197-keV level decay in ^{19}F through the 110-keV state. The results can be used to infer the extent of wave-function admixture (core excitation) in the ground state of ^{19}O. (Diss. Abstr. Int., B)

38894 MAJOR SHELL MIXING IN ^{12}C AND ^{16}O. Reid, Neal Evan. College Park, Md.; Univ. of Maryland (1970). 141p. University Microfilms Order No. 71-10,487.

Thesis.

A calculation of major-shell mixing is carried out for ^{12}C and ^{16}O in a truncated basis of oscillator states. Inasmuch as the usual type of Hartree–Fock calculations are unable to produce correct binding energies, in an effort to incorporate the main aspects of many-body theory a Brueckner–Hartree–Fock calculation is performed. This consists of the application of the Hartree–Fock variational procedure to the expression for the energy given by the Brueckner–Goldstone expansion. This gives rise to a term proportional to the derivative of the G matrix called the "rearrangement energy," which modifies the usual relation between the Hartree–Fock energy and the single-particle energies. Effective G-matrix elements were produced by parameterizations involving local and average densities. Both spherical and Cartesian oscillator bases were employed. The latter may be easily deformed by varying the length parameters in the three directions. It is more suitable than the spherical basis for describing nuclei with intrinsic deformations, such as ^{12}C. It is found that the explicit mixing of major shells, whether spherical or deformed, is basically different in character from the mixing that is implicitly present in the Nilsson model as a consequence of the deformations. (Diss. Abstr. Int., B)

38895 UNIFIED SHELL MODEL DESCRIPTION OF MASS 13 TO 20 NUCLEI. Franks, Billie Wayne. College Station, Tex.; Texas A and M Univ. (1970). 141p. University Microfilms Order No. 71-8874.

Thesis.

A ^{12}C core and a ($1p_{\frac{1}{2}}$, $1d_{\frac{5}{2}}$, $2s_{\frac{1}{2}}$) shell-model basis are used to provide a unified account of A = 13 to 20 nuclei. All possible configurations of the (A – 12) active particles are allowed. The residual two-body interactions and single-particle energies are reduced to linear expressions in 33 one- and two-body matrix elements. These matrix elements are then treated as parameters and varied until a best fit to approximately 100 known energy levels is obtained. From the values of these 33 parameters, the energies and wave functions of over 1000 positive- and negative-parity levels in this region are derived. The resulting wave functions are then used to calculate spectroscopic factors for stripping and pickup reactions and M1 and E2 electromagnetic transition rates. Tables and figures containing results of each of these calculations are presented along with the corresponding experimental values. In general, the results are in good agreement for each type of observable and would indicate that both typical single-particle and collective (rotational) phenomena emerge from the assumed shell-model basis. (Diss. Abstr. Int., B)

38896 EVIDENCE FOR A DIRECT EIGHT-NUCLEON TRANSFER REACTION AND MULTIPARTICLE EXCITATION OF ^{20}Ne. Marquardt, N.; von Oertzen, W.; Walter, R. L. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett.; 35B: 37-40 (26 Apr 1971).

Results from a study of the ^{12}C(^{14}N,^{6}Li)^{20}Ne reaction are presented which give evidence that the reaction proceeds via the direct transfer of eight nucleons. Comparison of the spectra of the emitted ^{6}Li particles to spectra from four-nucleon transfer reactions also leading to states in ^{20}Ne shows clear differences in the excitation of the various rotational bands. The selectivity of the (^{14}N,^{6}Li) reaction provides a new probe for investigating multiparticle-excited states and states having high angular momenta. (auth)

38897 ^{13}C GIANT RESONANCE AND EXCITED STATES OF THE RESIDUAL NUCLEI. Murray, K. M.; Toms, M. E. (Naval Research Lab., Washington, D. C.). Lett. Nuovo Cim.; 1: No. 14, 571-4(3 Apr 1971).

An enriched target of ^{13}C was irradiated by bremsstrahlung with endpoint energies of 21 and 28 MeV, and the decay gamma rays from excited states in the residual nuclei were observed at 90° to the beam. Gamma-ray spectra and strengths are given. The data indicate that the 15.11-MeV level in ^{12}C is fed to a large extent by neutrons emitted from the T = $\frac{3}{2}$ component of the giant resonance in ^{13}C. It is concluded that the strength of the decay via the 4.444-MeV state, compared to the total (γ,xn) strength, may be interpreted as demonstrating a large ratio of core excitation for the giant resonances of ^{13}C. (R.W.R.)

38898 INELASTIC SCATTERING OF MEDIUM-ENERGY PIONS FROM CARBON. Rogers, C.; Wilkin, C. (University Coll., London). Lett. Nuovo Cim.; 1: No. 14, 575-8(3 Apr 1971).

The distorted-wave impulse approximation, an approximation to Glauber theory where only those terms are kept that are proportional to a direct transition between the ground and excited states, is used to calculate the differential cross sections for pion inelastic scattering from the 2^+ and 3^- levels of ^{12}C at 180 and 260 MeV. (R.W.R.)

38899 DEPENDENCE OF CROSS SECTION OF ^{12}C NUCLEUS ELECTRODISINTEGRATION ON POTENTIAL PARAMETERS AND DISTORTION OF EJECTED NUCLEON WAVE FUNCTION. Pasichnyi, A. A.; Tartakovskii, V. K. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: 177-82(Feb 1971). (In Russian).

The dependence of the cross section for high-energy electrodisintegration of ^{12}C on the parameters of the optical potential is investigated. Correct solutions of the Schroedinger equation with the Woods–Saxon potential were taken as one-particle wave functions of nucleons in a bound state and state of positive energy. With an increase in the potential well the maxima of the momentum distributions of the nucleons (through which the cross sections are expressed) for 1s and 1p shell decrease, and with an increase in the diffuseness parameters they increase. Taking into account the distortion of the wave function results in a lowering of the maximum of the nucleon momentum distribution for the 1s shell and in a non-zero (and rather large) distribution in the 1p shell for a zero-momentum nucleon in the nucleus. (auth)

38900 NOTE ON THE PROTON INELASTIC SCATTERING TO THE FIRST 1^+ STATE OF ^{12}C. Mori, A. (Tokyo Univ.). Lett. Nuovo Cim.; 1: 703-6(24 Apr 1971).

The angular distribution for proton inelastic scattering at 46 MeV to the 1^+, T = 0 state in ^{12}C is calculated without a tensor potential but including the exchange effect, which turns out to be important. The l = 0 component is small, and the l = 1 contribution is the most important. (R.W.R.)

38901 ELASTIC AND INELASTIC SCATTERING OF PROTONS ON ^{14}N IN THE ENERGY REGION OF 10 TO 15 MeV. I. EXPERIMENTAL. Oda, Yukiyasu; Nakamura, Hitoshi; Yoshida, Akira; Kusuhara, Masako; Murakmi, Mariko. (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 30: No. 5, 1217-30(May 1971).

The elastic and inelastic scattering of protons by ^{14}N were studied at E_p = 11.90, 12.50, 13.29, 13.56, 13.93, 14.33 and 14.62

MeV. About twenty proton groups for the excited states of ^{14}N up to 9.51 MeV were observed. The angular distributions of the twelve groups were measured with angle steps of 5° at 14.33 MeV and with that of 15° at other energies. The results including those 10.2 and 10.5 MeV studied by Warburton et al. and by the University of Washington group respectively show that the distribution shapes vary in general remarkably with the proton energies. Resonance features were evidently recognized at $E_p \simeq 10.2$ MeV and also at 12 and 14 MeV. Systematics were found in the proton yields for the states with odd parity and T = 1. (auth)

38902 GROUND STATE ROTATIONAL BAND IN ^{8}Be AND THE INSTABILITY OF THE SU(3) CLASSIFICATION. Bouten, M. (SCK–CEN, Mol, Belgium); Bouten, M. C.; van Leuven, P. Nucl. Phys.; A168: No. 2, 438-48(1971).

The low-lying states of ^{8}Be are studied in three different approximations: the shell model without and with configuration interaction and the projected Hartree–Fock method. The calculation shows that the classification of states in SU(3) bands is destroyed when configuration mixing is taken into account. The configuration interaction calculation gives a clue to understanding the growth of the ground state rotational band in terms of different SU(3) representations. (auth)

38903 SCATTERING OF NUCLEONS BY ^{12}C AND THE STRUCTURES OF ^{13}N AND ^{13}C. Mikoshiba, O. (Science Univ. of Tokyo, Noda, Japan); Terasawa, T.; Tanifuji, M. Nucl. Phys.; A168: No. 2, 417-37(1971).

Scattering of protons and neutrons by ^{12}C was investigated by the coupled-channel method in collective models for the ^{12}C nucleus, paying particular attention to their resonance features. Weak spin-spin and l^2 dependent interactions were taken into account as the correction to the optical potential in the nuclear model. Phase shifts, cross sections and polarizations of elastic scattering for both the proton and the neutron, and total cross sections of inelastic scattering to the $^{12}C^*(2^+, 4.43$ MeV) state for the proton, up to $E_p = 8$ MeV and $E_n = 4$ MeV were calculated. The rotational model with large deformation of negative sign successfully reproduces experimental data but the vibrational model does not. (auth)

38904 $^{15}N(d,n)^{16}O$ REACTION AND STATES IN ^{16}O. Murphy, B. D.; Strang, R. M.; Ritter, R. C. (Univ. of Virginia, Charlottesville). Nucl. Phys.; A168: No. 2, 328-46(1971).

Bombardment of a gaseous ^{15}N target with deuterons has given absolute differential cross sections for the $^{15}N(d,n)^{16}O$ reaction. Complete angular distributions, taken from 0° to 150° (lab) at 4.83 and 5.84 MeV bombarding energy, were analyzed with a combination of DI and CN computer programs to derive l_p values and spectroscopic factors. Yield curves taken at an angle of 10° with 0.5 MeV steps from 2.5 MeV to 6.0 MeV were also analyzed with this combination of computer programs to give energy-averaged spectroscopic factors. The states observed and the l_p values are generally in agreement with those from previous (τ,d) experiments. The present results disagree with them, however, on summed strengths. Whereas the (τ,d) strengths essentially fulfill the sum-rule expectations for both the T = 0 and T = 1 components of the $2S_{\frac{1}{2}}$ and $1d_{\frac{5}{2}}$ configurations in the observed states the (d,n) results do not, thereby implying greater spreading of the strength. The following fractions of the sum rule values were observed: $(2S_{\frac{1}{2}}$, T = 0): 0.48; $(2S_{\frac{1}{2}}$, T = 1): 0.60; $(1d_{\frac{5}{2}}$, T = 0): 0.91; and $(1d_{\frac{5}{2}}$, T = 1): 0.61. There is no T-dependence of the (d,n) and (τ,d) differences. These differences as well as averages from all experiments are compared with shell-model calculations, and these results infer greater spreading of $2S_{\frac{1}{2}}$ strength than models show. To aid in discussing transition strengths a new "fractional transfer strength" which takes the value unity for any single-particle transfer is defined. (auth)

38905 $^{14}C(\tau,\alpha_0)^{13}C$ REACTION AT 6.0, 8.0, AND 10.0 MeV. Coker, W. R. (Univ. of Texas, Austin); Miller, P. D.; Duggan, J. L.; (and others). Nucl. Phys.; A168: No. 2, 307-13(1971).

Angular distributions for $^{14}C(\tau,\alpha)^{13}C$ leading to the ground state of ^{13}C were obtained at incident ^{3}He energies of 5.98, 8.0 and 10.0 MeV. $^{14}C(\tau,\tau)^{14}C$ angular distributions were obtained at the same energies and used to obtain optical potentials for the entrance channel of (τ,α). Exit channel optical potentials were extracted from $^{13}C(\alpha,\alpha)^{13}C$ angular distributions at 15.0, 18.0, 20.0 and 28.4 MeV. A DWBA analysis of the (τ,α) data was performed. (auth)

38906 EXTRAPOLATION OF THE $^{12}C + ^{12}C$ AND $^{12}C + ^{16}O$ REACTION CROSS SECTIONS TO ASTROPHYSICAL ENERGIES. Nagorcka, B. N. (Australian National Univ., Canberra); Symons, G. D.; Zuk, W. M.; Patterson, J. R. Nature (London) Phys. Sci.; 231: 17-18(3 May 1971).

A previous extrapolation of the $^{12}C + ^{12}C$ reaction cross section was re-evaluated in the light of new measurements of the $^{12}C + ^{16}O$ reaction which suggested that the "quasi-molecular" resonances that dominate the cross section at energies near the Coulomb barrier are apparently absent at the low energies available at stellar temperatures. The $^{12}C(^{16}O,\alpha)^{24}Mg$ and $^{12}C(^{16}O,p)^{27}Al$ reactions, which constitute the chief part of the total reaction yield, were studied for center of mass energies from 4.54 to 8.53 MeV, and the total cross sections were measured at intervals of 40 to 90 keV; a list of cross sections for these energies is given in tabular form. The $\tilde{S}$ factors for the $^{12}C + ^{16}O$ and $^{12}C + ^{12}C$ reactions are shown graphically for the energy range 3 to 9 MeV. Above a center of mass energy of about 6 MeV the cross sections of the $^{12}C + ^{16}O$ reactions are dominated by "quasi-molecular" resonances similar to those seen in the $^{12}C + ^{12}C$ reactions, but below about 6 MeV the $\tilde{S}$ factor becomes approximately constant, allowing a straight line extrapolation to lower energies. This result prompted the re-evaluation of the $^{12}C + ^{12}C$ data and it was concluded that extrapolation may be made in this case in a similar manner on the basis of the cross sections below 4 MeV. For $^{12}C + ^{16}O$ reactions the extrapolated cross sections at 3.0, 3.5 and 4.0 MeV were found to be 1.0×10^{-11}, 1.1×10^{-9} and 4.6×10^{-8} barns, respectively, and for $^{12}C + ^{12}C$ reactions at 2.0, 2.5 and 3.0 MeV they were found to be 1.4×10^{-11}, 4.9×10^{-9}, and 3.2×10^{-7} barns, respectively. The uncertainty is approximately −40% and +50% for the $^{12}C + ^{16}O$ extrapolation and −30% and +45% for $^{12}C + ^{12}C$ at the energies quoted. The results are of interest in connection with theoretical work on the role of C burning in nucleosynthesis and energy generation, and in hydrostatic C burning. (UK)

38907 $^{18}O(^{3}He,n_0)^{20}Ne$ AND $^{18}O(^{3}He,n_1)^{20}Ne$ REACTIONS FROM 2.0 TO 4.6 MeV. Din, G. U. (Australian National Univ., Canberra); Weil, J. L. Aust. J. Phys.; 24: No. 2, 139-43(Apr 1971).

The 0° excitation functions were measured for the ground and first excited state neutron groups from the $^{18}O(^{3}He,n)^{20}Ne$ reaction in the range of 2.0 to 4.6 MeV for the ^{3}He bombarding energy. The yield curves for both neutron groups show prominent overlapping resonance structure. The angular distributions for both groups were measured at bombarding energies of 2.80, 3.17, 3.56, 3.77, 4.17, and 4.64 MeV. These distributions show considerable structure and vary with ^{3}He energy, though the yield in the forward direction is usually larger than in the backward direction. The largest cross section at any angle does not exceed 0.4 mb sr^{-1} in this range of bombarding energy. Compound nucleus formation appears to be an important part of the reaction mechanism in this energy region, though a direct reaction contribution cannot be ruled out. (auth)

38908 ABSOLUTE ^{7}Li PHOTOTRITON CROSS-SECTION MEASUREMENTS USING THERMAL-NEUTRON-CAPTURE GAMMA RAYS. Seeser, James William. Columbia, Mo.; Univ. of Missouri (1970). 155p. University Microfilms Order No. 71-3381.

Thesis.

Phototritons from ^{7}Li were studied using a beam of discrete-energy gamma rays emitted from thermal-neutron capture in individual nickel, chromium, manganese and aluminum sources. Relative phototriton differential cross sections were obtained by measuring the triton yields at various angles between 30 and 160 degrees using a large surface-barrier detector. The observed triton energy spectra containing components due to different gamma-ray energies were reduced using a least-square analysis to yield the relative intensities of each of the respective triton-energy groups. From these data relative differential cross sections and relative total yields were calculated. Phototriton angular distributions for the various incident gamma-ray energies are also presented. After measuring the gamma-ray flux for the highest energy components of each of the different capture-gamma-ray spectra, precise values of the absolute phototriton cross sections were then determined at those energies. Then, using the experimentally measured relative yields of tritons from each source and the known relative gamma-ray intensities, a calculation was made for the absolute total phototriton cross sections at each of the other incident gamma-ray energies. The total cross section measurements confirm that a broad peak (or peaks) with a total width of about 0.5 MeV exists at a gamma-ray energy of about 8.2 MeV. A very pronounced but previously unobserved peak was observed in the vicinity of 7.71 MeV with an apparent width less than 0.15 MeV. The measured total cross sections ranged from 560 ± 100 μb at 7.723 MeV to 106 ± 18 μb at 9.716 MeV. The asymmetries at the angular distributions at 7.723 and 7.820 MeV give evidence for positive parity levels in this region. (Diss. Abstr. Int., B)

38909 STUDY OF HIGH ENERGY PHOTONEUTRONS EMITTED FROM THE 1P-SHELL IN ^{12}C. Miller, Henry Gilbert. Sas-

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katoon; Univ. of Saskatchewan (1970). 101p. University Microfilms Order No. 71-3228.

Thesis.

Photoneutron spectra from ^{12}C were measured at bremsstrahlung end tip energies from 64 to 128 MeV in 2 MeV steps. The spectra were obtained simultaneously at five angles using time-of-flight techniques. The measured cross sections exhibit "kinematic resonances" corresponding to the emission of a single neutron from the 1P-shell in ^{12}C. The angular distributions of these P-shell neutrons are forward asymmetric, the asymmetry increasing with neutron energy. The results are compared with the single-particle and cluster theories. It has been found that the angular distributions and the differential cross section at 90° can be explained best by the quasi-alpha model and therefore it is concluded that dynamic correlations between nucleons in the same shell are more important than those between nucleons in different shells. (Diss. Abstr. Int., B)

38910 STUDY OF MIRROR STATES IN A = 19 WITH THE (^{6}Li,t) AND (^{6}Li,^{3}He) REACTIONS ON ^{16}O. Bingham, H. G.; Fortune, H. T.; Garrett, J. D.; Middleton, R. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 26: No. 23, 1448-51(7 Jun 1971).

The reactions $^{16}O(^6Li,^3He)^{19}F$ and $^{16}O(^6Li,t)^{19}Ne$ were performed at an incident energy of 24 MeV. The observed strong selectivity of these reactions suggests a predominantly direct-reaction mechanism and allows the identification of several isobaric analogs in ^{19}F and ^{19}Ne. (auth)

38911 β DECAY OF ^{8}Li AND ^{8}B: THE SECOND-CLASS CURRENT PROBLEM. Wilkinson, D. H. (Brookhaven National Lab., Upton, N. Y. Univ. of Washington, Seattle); Alburger, D. E. Phys. Rev. Lett.; 26: 1127-30(3 May 1971).

Measurement of the excitation spectra of ^{8}Be following the decays of ^{8}Li and ^{8}B permits the comparison of mirror Gamow–Teller transitions over a wide range of $W_0^+ + W_0^-$, largely free of uncertainties associated with possible T_z dependencies of nuclear overlap integrals. We find no evidence for second-class currents: using the conventional parametrization, we find that $|g_{IT}| < 7 \times 10^{-4}$ at the 99% confidence level as against $g_{IT} \approx 2 \times 10^{-3}$ that comes from the direct comparison of absolute ft values. (auth)

38912 REACTIONS ^{7}Li(^{3}He,d)^{8}Be AND ^{7}Li(^{3}He,p)^{9}Be AND CHANNELING OF IONS IN CRYSTALS. Dixon, Robert Leland. Columbia, S. C.; Univ. of South Carolina (1970). 216p. University Microfilms Order No. 71-9711.

Thesis.

The reactions ^{7}Li(^{3}He,d)^{8}Be and ^{7}Li(^{3}He,p)^{9}Be were induced by 10-MeV ^{3}He particles. Angular distributions were measured, absolute cross sections were determined, and an excitation function was measured over the energy range of 3 to 11 MeV. The reaction ^{7}Li(^{3}He,d)^{8}Be proceeds via stripping, and distorted-wave Born-approximation calculations give a satisfactory fit to the data. Spectroscopic factors were determined ($S(0^+) = 3.18$, $S(2^+) = 2.80$). The reaction ^{7}Li(^{3}He,p)^{9}Be does not appear to proceed via double-stripping, a direct reaction mechanism is indicated for the transitions to the ground and first excited states of ^{9}Be. Escape of 500-keV protons from channels in CaF_2 and LiF crystals was studied by means of a new technique utilizing charged-particle spectra from proton-induced reactions. The most powerful technique developed is the use of a resonant reaction in which charged particles are emitted. The reaction $^{19}F(p,\alpha)^{16}O$, which has a resonance at 340 keV only 3 keV wide, was used. Protons introduced at 500 keV slow down in the crystal to 340 keV, at which point the resonant reaction occurs. Since the energy of an emerging alpha particle is uniquely related to the depth at which the reaction occurs, and since protons can only react after escaping the channel, the emergent-alpha-particle spectrum can be used to map the spatial distribution of protons escaping the channel. The stopping power in the channel can also be determined from the minimum alpha-particle energy observed. The ^{3}He spectrum from the non-resonant reaction $^6Li(p,\alpha)^3He$ was also used. The escape from channels was found to obey an exponential law, and the half-thickness for channel escape was measured as well as the channel stopping power. The channel stopping power for ⟨100⟩ channels in LiF was 87 percent of the random stopping power, and the half thickness for channel escape was .115 mg/cm^2. The corresponding quantities for CaF_2 are 95 percent and .618 mg/cm^2. (TSS) (Diss. Abstr. Int., B)

38913 ^{7}Li + ^{3}He REACTION AT LOW ^{3}He ENERGY. Stanojevic, D. M.; Aleksic, M. R.; Stepanic, B. Z.; Popic, R. V. (Boris Kidric Inst. of Nuclear Science, Belgrade). Fizika (Zagreb); 3: No. 2, 99-103(Apr 1971).

The reactions ^{7}Li(^{3}He,p)^{9}Be and ^{7}Li(^{3}He,d)^{8}Be were investigated in order to study the reaction mechanism and to extract data concerning the $E_{^3He} = 1.1$ MeV resonance in ^{10}B. The excitation curves for the p_0, p_2, and d_0 groups and the angular distributions of the p_0, p_2, p_3, and d_0 groups show that the ^{7}Li(^{3}He,p)^{9}Be reaction proceeds via a ^{10}B compound state at $E_x = 18.5$ MeV with $\Gamma = 100$ to 400 keV, $J^\pi = 2^-$, and $T = 1$ (the nearest state at 18.8 MeV is most probably a 2^+ state), and that the ^{7}Li(^{3}He,d)^{8}Be reaction proceeds via a direct stripping mechanism. (auth)

38914 DEORIENTATION MEASUREMENT IN ^{20}Ne. Faessler, M. A.; Povh, B.; Schwalm, D. (Univ., Heidelberg. Max-Planck-Institut fuer Kernphysik, Heidelberg). Ann. Phys. (N. Y.); 63: No. 2, 577-85(Apr 1971).

The dependence of the attenuation of the $\alpha-\gamma$ correlation on the velocity was measured for the first excited 2^+ state in ^{20}Ne recoiling into vacuum. The observed attenuation can be explained by a time-independent, isotropic magnetic hyperfine interaction between the nucleus and (mainly) those electron configurations having unpaired $1s_{\frac{1}{2}}$ or $2s_{\frac{1}{2}}$ electrons. The possibility of measuring nuclear magnetic moments of states with lifetimes down to 10^{-14} sec is discussed. (auth)

38915 NEW GAMMA-RAY BRANCHING RATIOS IN ^{16}N AND THEIR IMPLICATIONS ON THE MUON PARTIAL CAPTURE RATES IN ^{16}O. Palffy, L. (Univ. Louvain, Belg.); Lehmann, J.; Grenacs, L.; Subotowicz, M. Nuovo Cim.; 3A: No. 3, 505-10 (1 Jun 1971).

Gamma-ray branching ratios were measured in ^{16}N by bombarding NH_4NO_3 targets enriched in ^{15}N with deuterons and using high-resolution gamma spectrometers. The following results were obtained: $I_{276\,keV}/I_{396\,keV} = 2.76 \pm 0.06$, $I_{100\,keV}/I_{276\,keV} \leq 2 \cdot 10^{-3}$, and $I_{176\,keV}/I_{296\,keV} \leq 1 \cdot 10^{-2}$. In the light of these branching ratios the muon partial capture rates to the ^{16}N excited bound states are reconsidered and briefly discussed. (auth)

38916 j-DEPENDENCE OF POLARIZATION IN THE ^{11}B(d,n_0) AND ^{11}B(d,n_1) REACTIONS. Meier, M. M.; Purser, F. O.; Morgan, G. L.; Walter, R. L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Triangle Park, N. C.). pp 409-12 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

Polarization distributions for neutrons from the $^{11}B(d,n_0)$ and $^{11}B(d,n_1)$ reactions have been obtained in the angular range 10°(L) to 135°(L) for energies between 2.8 and 4.0 MeV. The energy dependence is quite weak; this result indicates the predominance of a direct mechanism in producing the polarization. The sign of the polarization at forward angles is different for the two transitions; this finding indicates the dependence of this quantity on the j-value of the transferred proton. (auth) (Canada)

38917 NEUTRON POLARIZATION IN THE (^{3}He,n) REACTIONS ON ^{11}B AND ^{13}C. Thomason, R. S.; Stammbach, Th.; Taylor, J.; Walter, R. L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Triangle Park, N. C.). pp 413-20 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

Neutron polarizations measured in $^{11}B(^3He,n)^{13}N$ and $^{13}C(^3He,n)^{15}O$ reactions are compared with DWBA calculations. (auth) (Canada)

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Refer also to abstracts 37593, 37633, 37762, 38540, 38630, 38640, 38877, 38880, 38885, 38887–38889, 38893, 38895, 38969, 38972, 38982, 38984, 38988, 39006, 39011, 39031, 39042, 39043, 39048, 39050, 39056–39058, 39078, 39088, 39096, 39123, and 39127.

38918 (AERE-R-6473) STUDY OF THE NUCLEI ^{12}N, ^{16}F, ^{22}Mg, ^{26}Si, AND ^{30}S BY (^{3}He,n) REACTIONS. Adams, J. M.; Adams, A.; Calvert, J. M. (Atomic Energy Research Establishment, Harwell (England)). Feb 1971. 38p. Dep. NTIS (U. S. Sales Only).

Fast neutron time-of-flight techniques were used to study the five proton-rich nuclei ^{12}N, ^{16}F, ^{22}Mg, ^{26}Si, and ^{30}S by means of (^{3}He,n) reactions. In all cases the ground-state reaction Q values,

the mass of the residual nuclei, and the low-lying level structure of the residual nuclei were determined to a fairly high accuracy. Angular distributions were measured for the three neutron groups corresponding to excitation of the first three levels in ^{13}N for the $^{10}B(^3He,n)^{12}N$ reaction at 2.4, 2.75, and 2.94 MeV incident energies. The neutron group 0° excitation functions corresponding to these levels were measured between 1.73 MeV and 3.19 MeV. The ground- and first-excited-state neutron-group angular distributions for the $^{20}Ne(^3He,n)^{22}Mg$ reaction were measured at an incident energy of 3.045 MeV. The ground-state neutron-group angular distribution for the $^{24}Mg(^3He,n)^{26}Si$ reaction was measured at an incident energy of 3.14 MeV. (auth)

38919 (CCDN-NW-10) NEWSLETTER BULLETIN NO. 10. (ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France)). Dec 1969. 142p. Dep. NTIS (U. S. Sales Only).

A semi-empirical evaluation of fast neutron radiative capture cross sections of $32 \leq Z \leq 66$ stable nuclei is presented. A survey of total cross-section measurements for lead below 100 keV, and a list of the data available on $\bar{\nu}$ for ^{252}Cf in the CCDN data library are also included. (J.W.R.)

38920 (CEA-N-1444) MEASUREMENT OF ^{89}Rb GAMMA RAY ENERGIES. Bechemilh, Jean-Pierre; Le Meur, Roger; Poux, Christiane (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 18 Mar 1971. 10p. (In French). Dep. NTIS (U. S. Sales Only).

Gamma radiation lines of ^{89}Rb from fission products on a filter were measured. A Ge(Li) detector and a 4,000 channel analyzer were used in the measurements. The relative abundances and the half lives were calculated. The possibility of a mutual interaction between the photoelectric peaks and the resonance escape lines is examined. An order of magnitude for the detection threshold is given for the installation. (France)

38921 (EURFNR-591(Suppl.1)) HIGH RESOLUTION TOTAL NEUTRON CROSS SECTIONS FOR Si, Cr AND Ni BETWEEN 0.5 AND 30 MeV. Cierjacks, S.; Forti, P.; Kopsch, D.; Kropp, L.; Nebe, J.; Unseld, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Oct 1968. 44p. (KFK-1000(Suppl.1); EUR-3963(Suppl.1); EANDC(E)-111-U(Suppl.1)). Dep. NTIS (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

Data on neutron total cross sections at 0.4 to 32 MeV for Si, Cr, and Ni are presented graphically. (J.W.R.)

38922 (EURFNR-591(Suppl.2)) HIGH RESOLUTION TOTAL NEUTRON CROSS SECTIONS FOR Na, Cl, K, V, Mn AND Co BETWEEN 0.5 AND 30 MeV. Cierjacks, S.; Forti, P.; Kopsch, D.; Kropp, L.; Nebe, J.; Unseld, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Feb 1969. 85p. (KFK-1000(Suppl.2); EUR-3963(Suppl.2); EANDC(E)-111-U(Suppl.2)). Dep. NTIS (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

Data on neutron total cross sections at 0.3 to 32 MeV for Na, Cl, K, V, Mn, and Co are presented graphically. (J.W.R.)

38923 (JAERI-1205, pp 28-35) (γ,γ') REACTION ON sd-SHELL NUCLEI. Shikazono, Naomoto (Japan Atomic Energy Research Inst., Tokyo). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

The resonant scattering experiment was carried out with gamma rays from bremsstrahlung. Odd mass nuclei in sd-shell region were studied, e.g., ^{19}F, ^{23}Na, ^{27}Al, ^{31}P, $^{35,37}Cl$ and ^{39}K. Many resonant peaks were observed in ^{19}F, ^{23}Na, ^{27}Al and ^{31}P, while in Cl and K, no prominent peak was recognized. The lowest $T = 3/2$ states in ^{23}Na and ^{31}P were investigated. The M1 transition strengths of these states were compared with the ft values of analogous Gamow–Teller β decays. (auth)

38924 (JAERI-1205, pp 96-9) ELECTROMAGNETIC FORM FACTOR OF ^{20}Ne. Horikawa, Yataro (Tokyo Univ. (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

The Coulomb form factors for electromagnetic transitions in the ground state band of ^{20}Ne are examined with the rotor model, the intrinsic wave function being the Slater determinant of the single particle wave functions in the deformed potential. In order to explain strong enhancements for both $(0^+ \rightarrow 2^+)$ and $(0^+ \rightarrow 4^+)$ transitions it is necessary to introduce Y_4 deformation in the potential in addition to the usual Y_2 deformation. The form factor of $(0^+ \rightarrow 6^+)$ is also calculated. (auth)

38925 (NP-18712, pp 19-34) PHYSICS. (Bose Inst., Calcutta (India)).

In Report of the Bose Institute for 1968–69.

The cross sections for the (n,2n) reaction with fifteen nuclides from ^{19}F to ^{141}Pr are given at 14.8 MeV; cross sections for ten of these were also measured at 14.2 MeV. The electron charge distributions of Sn and Pb were calculated. The cross sections for pair production at different angles were measured. Radio-wave absorption by the ionosphere was measured, and several modes of variation were investigated. (R.W.R.)

38926 (NP-18854) DEVELOPMENT OF A COINCIDENCE SYSTEM BETWEEN CHARGED PARTICLES AND GAMMA RAYS. APPLICATION TO THE STUDY OF GAMMA DEEXCITATION OF ^{41}Ca LOW ENERGY LEVELS. Cohen, Serge (Paris Univ., Orsay (France). Faculte des Sciences). [nd]. 47p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A gamma-charged particle coincidence system was developed using a magnetic spectrometer. The gamma spectra obtained enabled the branching ratios of the following ten excited levels of ^{41}Ca to be determined: 3200, 3369, 3400, 3495, 3527, 3614, 3676, 3730, 3845, and 3976. Spins and parities were proposed for some of them. (France)

38927 (ORNL-4617) RE-EVALUATION OF NATURAL IRON NEUTRON AND GAMMA-RAY PRODUCTION CROSS SECTIONS-ENDF/B MATERIAL 1124. Penny, S. K.; Kinney, W. E. (Oak Ridge National Lab., Tenn.). Apr 1971. Contract W-7405-eng-26. 73p. Dep. NTIS.

Recent data and good agreement between calculated and experimental cross sections prompted the re-evaluation of natural iron neutron and gamma-ray production cross sections for ENDF/B use with the aim of improving angular distributions and extending inelastic level excitation cross sections. Calculations are described and are shown to be in good agreement with experiment. Below 2 MeV, neutron elastic scattering cross sections and cross sections for inelastic scattering to levels in ^{56}Fe are obtained from experimental results. Above 2 MeV, neutron elastic scattering cross sections and cross sections for inelastic scattering to levels in ^{56}Fe up to an excitation energy of 4.116 MeV are obtained from calculations. Cross sections for inelastic scattering to the continuum are obtained from fits to experimental results. The total cross sections are the evaluated cross sections of Irving and Straker from 330 keV to 15 MeV and those of the U.K. evaluation DFN-91 from 10^{-5} eV to 330 keV. The (n,p) and (n,α) cross sections were taken from the U.K. evaluation DFN-91, while the (n,2n) cross sections are those of ENDF/B material 1122. The (n,γ) cross sections were taken from U.K. DFN-91. The gamma-ray production cross sections and associated gamma-ray spectra were calculated from the evaluated (n,n') and (n,γ) cross sections together with known and assumed branching ratios. The evaluated cross sections are presented in graphical form. (auth)

38928 SPECIFIC BETA ACTIVITY OF POTASSIUM. Venkataramaiah, P.; Sanjeevaiah, H.; Sanjeevaiah, B. (Univ. of Mysore, India). Indian J. Pure Appl. Phys.; 9: No. 2, 133-4 (Feb 1971).

The half-life of ^{40}K for beta emission was measured by employing the method of absolute beta counting. Corrections for the absorption of beta particles in air and the counter window, backscattering from the source, holder, and self-absorption in the source sample were made by the extrapolation technique. The values obtained for specific beta activity of natural potassium and the partial half-life of ^{40}K for beta emission compare well with those of previous measurements. (auth)

38929 SPIN-EXCHANGE POLARIZATION AND Hfs ANOMALY MEASUREMENT OF β-ACTIVE ^{37}K. von Platen, Ch.; Bonn, J.; Koepf, U.; Neugart, R.; Otten, E.-W. (Univ., Heidelberg). Z. Phys.; 244: 44-69(1971).

Rf-spectroscopic measurements in the atomic ground state of the 1.2-sec isotope ^{37}K yielded independent values of magnetic moment $\mu_I(^{37}K) = 0.20320\ (6)$ nm (diamagnetically corrected), hfs separation $\Delta W(^{37}K) = 240.2672\ (7)$ MHz, and the resulting hfs anomaly $^{37}\Delta^{39} = (0.249 \pm 0.035) \cdot 10^{-2}$. The ^{37}K was polarized by spin-exchange scattering with optically pumped ^{87}Rb; as a detector of rf transitions the asymmetry of the β decay of the polarized ^{37}K nuclei was used. A detailed analysis of the spin-exchange mechanism under the conditions of experiments of this type was performed. This led to an explanation for the observed strong enhancement of the resonance signal heights by the spin bath.

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Furthermore, the dependence of the nuclear polarization and relaxation time constants on the strength of the hfs coupling could be demonstrated. (auth)

38930 ELASTIC SCATTERING OF ^{16}O FROM EVEN Ca ISOTOPES NEAR THE COULOMB BARRIER. Bertin, M. C. (Stanford Univ., Calif.); Tabor, S. L.; Watson, B. A.; Eisen, Y.; Goldring, G. Nucl. Phys.; A167: 216-24(1971).

The elastic scattering of ^{16}O from $^{40,44,48}Ca$ was studied at incident energies in the neighborhood of the Coulomb barrier. An optical-model analysis established that only two independent parameters are determined. These are most appropriately chosen as r_R, the radius of the maximum of the total potential, V(r) (Coulomb plus nuclear), and f, defined by $f = 1 - r_R V(r_R)/Z_1Z_2e^2$. The significance of these parameters is examined in detail. Unlike the mean radius of the charge distribution, which is roughly constant for the three Ca isotopes, the Rutherford radius, r_R, is found to increase approximately as $A^{\frac{1}{3}}$. (auth)

38931 RESONANCE FLUORESCENCE STUDIES OF LEVELS IN ^{23}Na AT ABOUT 7 MeV. Swann, C. P. (Franklin Inst., Swarthmore, Pa.). Nucl. Phys.; A167: 201-6(1971).

The Doppler-broadened 6.92- and 7.12-MeV radiation from the $^{19}F(p,\alpha\gamma)^{16}O$ reaction was used for resonance excitation of levels in ^{23}Na at 6.923, 6.953, 7.075, 7.086, and 7.138 MeV. From observed branchings and angular-distribution measurements of the scattered radiation, probable spin–parity assignments of $\frac{5}{2}^+$ and $\frac{3}{2}^+$ are made for the 7.075- and 7.086-MeV levels, respectively, and the corresponding widths for the ground-state transitions were calculated to be 0.68 ± 0.14 and 1.10 ± 0.22 eV. Only limits could be placed on the spins and parities for the other levels. Possible values for the amplitude mixing ratios are also given. (auth)

38932 STRUCTURE IN THE GIANT RESONANCE OF ^{59}Co. Baciu, G.; Catana, D.; Deberth, C.; Iliescu, C.; Carstoiu, B. (Inst. for Atomic Physics, Bucharest). Nucl. Phys.; A167: 177-82(1971).

The cross section for the $^{59}Co(\gamma,xn)$ reaction was measured from threshold to 22 MeV with a small energy bin (≈100 keV). Marked structure was observed in the least-structure solution for the photoneutron production cross section. The integrated cross section was found to be 598.7 ± 0.9 MeV · mb. Good agreement is found with the predictions of the dynamic-collective-model calculations of Huber in the region of the giant resonance. Considerably more structure with appreciable strength is found experimentally in the region below 16 MeV; this result indicates a deficiency in the model in its present form. (auth)

38933 EXPERIMENTAL STUDY OF THE $^{24}Mg(d,p)^{25}Mg$ REACTION IN THE ENERGY RANGE 650 TO 500 keV. Mesko, L.; Schlenk, B.; Valek, A. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 29: No. 4, 365-71 (1970).

Angular distributions and absolute cross sections of the p_0, p_1, p_2, p_3 and p_4 groups from the reaction $^{24}Mg(d,p)^{25}Mg$ were measured in the range E_d = 650 to 500 keV with a semiconductor detector. The angular distributions are asymmetrical about 90°, their shapes vary strongly with deuteron energy and the p_1 and p_2 groups have the largest cross sections. The experimental data were analyzed in terms of Legendre polynomials. (auth)

38934 STUDY OF THE $^{18}O(^7Li,t)^{22}Ne$ AND $^{21}Ne(d,p)^{22}Ne$ REACTIONS AND THE NUCLEAR STRUCTURE OF ^{22}Ne. Neogy, Partha. Philadelphia; Univ. of Pennsylvania (1970). 120p. University Microfilms Order No. 71-7838.

Thesis.

The $^{18}O(^7Li,t)^{22}Ne$ and $^{21}Ne(d,p)^{22}Ne$ reactions were studied with 12.0 MeV $^7Li^{+++}$ and d^+ beams from a Model EN tandem Van de Graaff accelerator. The reaction products were analyzed with a multi-angle magnetic spectrograph. Triton spectra were simultaneously recorded at 23 angles varying in $7\frac{1}{2}°$ steps from $3\frac{3}{4}°$ to $168\frac{3}{4}°$. Proton spectra were similarly recorded over the angular range from $7\frac{1}{2}°$ to $82\frac{1}{2}°$. Angular distributions were extracted for 22 triton groups leading to states in ^{22}Ne up to 8.59 MeV excitation energy. A finite range plane wave Born approximation model was developed to calculate differential cross sections for the alpha transfer reaction. The projectile form factor was evaluated by employing a p-state cluster model wave function. Coulomb distortion effects were taken into account in the local energy WKB approximation. The predictions of the model were compared with the experimental angular distributions; L-values were assigned and relative alpha-particle widths were extracted for the strong transitions. Angular distributions of protons were extracted for 31 transitions leading to states in ^{22}Ne up to 9.10 MeV excitation energy. Angular momentum transfers were identified and spectroscopic factors extracted for 27 levels by comparison with DWBA predictions. Experimental spectroscopic factors for the low lying states were compared with the predictions of the Nilsson model. Significant alpha clustering was observed for 10 states in ^{22}Ne between 6.24 and 8.59 MeV excitation energy. Spin and parity assignments were made to these states from the combined results of the $(^7Li,t)$ and (d,p) reactions. In addition to the well known ground state rotational band, the results of the $^{21}Ne(d,p)^{22}Ne$ reaction indicate the presence of a $K = 2^+$ band with bandhead at 4.46 MeV, a $K = 1^+$ band with bandhead at 5.36 MeV, and a $K = 4^+$ bandhead at 5.52 MeV. The results of the $^{18}O(^7Li,t)^{22}Ne$ reaction suggest the presence of a $K = 1^-$ band based on the state at 7.06 MeV, and three $K = 0^+$ bands on the states at 6.24, 6.90, and 7.34 MeV. (Diss. Abstr. Int., B)

38935 SHAPE MIXING AND THE SHELL-MODEL DESCRIPTION OF THE ISOTOPES OF NEON. Macfarlane, M. H.; Shukla, A. P. (Argonne National Lab., Ill. Univ. of Chicago). Phys. Lett.; 35B: 11-15(26 Apr 1971).

The shell-model spectra of ^{20}Ne and ^{21}Ne within $(1d,2s)^n$ are reproduced to within 100 keV by angular-momentum projection from a few deformed Hartree–Fock intrinsic states. The prolate HF ground state, the lowest axially asymmetric state and the interaction between them play an essential role. (auth)

38936 INVESTIGATIONS OF γ SPECTRA OF CERTAIN (p,γ) RESONANCES. Demeter, I. (Central Research Inst. for Physics, Budapest); Fodor, Ilona; Keszthelyi, L.; (and others). Acta Phys. Acad. Sci. Hung.; 30: No. 1, 1-9(1971).

The investigations of γ spectra of the isobaric analog resonances give useful information about the structure of the nuclei. Results are given for isobaric analog resonances in (p,γ) reactions on several intermediate nuclei, and the systematics of their γ spectra are studied. (auth)

38937 COLLECTIVE-MODEL ANALYSIS OF INELASTIC PROTON SCATTERING USING POTENTIALS DERIVED FROM NUCLEAR MATTER DISTRIBUTIONS. Hnizdo, V.; Lowe, J. (Univ. of Birmingham, Eng.). Phys. Lett.; 35B: 35-6(26 Apr 1971).

Inelastic scattering of 30.3 MeV polarized protons is analyzed using an extension of the folding procedure recently applied to elastic scattering analysis. The resulting fits are in general better than those achieved with the standard coupled-channels procedure. (auth)

38938 STUDY OF THE $^{40}Ca(p,2p)^{39}K$ REACTION AT 45.0 MeV. Bray, K. H. (Univ. of Manitoba, Winnipeg); Bunker, S. N.; Jain, M.; (and others). Phys. Lett.; 35B: 41-3(26 Apr 1971).

Angular correlations for the reaction $^{40}Ca(p,2p)^{39}K$ were measured at symmetric, coplanar angles between 30° and 105° for both the ground state and first excited state of ^{39}K. The angular correlations are compared with a distorted-wave t-matrix calculation using a non-local bound-state wave function. (auth)

38939 DEPENDENCE OF ANGULAR DISTRIBUTIONS OF INELASTICALLY SCATTERED NEUTRONS ON THE MOMENT OF INERTIA OF THE COMPOUND NUCLEUS. Fedorov, M. B.; (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: 280-3(Feb 1971). (In Russian).

The experimental angular distributions from the inelastic scattering of 2.9-MeV neutrons by Cr nuclei and of 2.45-MeV neutrons by Ni nuclei are compared with calculations according to the Hauser–Feshbach theory. The formula is obtained for the dependence of the differential cross sections on the moment of inertia of the compound nucleus. Some disagreements between the Hauser–Feshbach theory and the experimental results are attributed to the small value of the compound-nucleus moment of inertia. (auth)

38940 INVESTIGATION OF $^{27}Al(d,\alpha)^{25}Mg$ NUCLEAR REACTION IN THE ENERGY RANGE 650 TO 540 keV USING A PLASTICS TRACK DETECTOR. Hunyadi, I.; Schlenk, B.; Somogyi, G.; Srivastava, D. S. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung.; 30: No. 1, 73-9(1971).

The angular distributions of the α_1 and A_1 groups from the $^{27}Al(d,\alpha)^{25}Mg$ nuclear reaction were measured at deuteron energies E_d = 650, 585, and 540 keV by using plastic track detector techniques. The angular distributions, which are nearly isotropic, are analysed in terms of the Legendre polynomials. For an assumed statistical compound reaction mechanism the relative-intensity ratio of the two measured alpha groups can be reproduced by a simple calculation giving the statistical weight factors for the alpha transitions concerned. (auth)

38941 EVOLUTION OF THE CONTENT OF OXYGEN AT THE SURFACE DURING NUCLEAR REACTIONS. Weber,

G.; Quaglia, L. (Univ., Liege). Nucl. Instrum. Methods; 94: No. 1, 165-71(1971). (In French).

The behaviour of the oxygen content at the surface of several metals during the bombardment by charged particles has been investigated. This study was made to determine the best experimental conditions and to put the users of this method on their guards against some unexpected behaviour of oxygen content. (auth)

38942 NUCLEAR SPECTROSCOPY USING (p,γ) REACTIONS: APPLICATION TO ^{56}Co AND ^{58}Co NUCLEI. Drouin, R. (Univ., Strasbourg). pp 223-33 of Comptes Rendus du 92e Congres National des Societes Savantes. Tome 2. Paris; Bibliotheque Nationale (1970). (In French).

From ninety-second national congress of the Learned Societies; Strasbourg, France (31 Mar 1967). See CONF-670342-(Vol.2).

Using the threshold radiation method with (p,γ) reactions, the excited levels of certain odd-odd nuclei were observed and studied. Only a single level situated at 160 ± 3 keV was observed for ^{56}Co with an excitation energy less than 360 keV, while for ^{58}Co the levels observed and studied were: 115 ± 3 keV, 365 ± 3 keV, 433 ± 3 keV, 717 ± 3 keV, 1050 ± 5 keV, 1238 ± 3 keV, 1378 ± 3 keV and 1438 ± 3 keV. (auth) (France)

38943 β-RADIOACTIVE ISOTOPES WITH HALF-LIVES OF A FEW SECONDS. Frick, G. (Univ., Strasbourg). pp 235-44 of Comptes Rendus du 92e Congres National des Societes Savantes. Tome 2. Paris; Bibliotheque Nationale (1970). (In French).

From ninety-second national congress of the Learned Societies; Strasbourg, France (31 Mar 1967). See CONF-670342-(Vol. 2).

The methods used for making measurements on the spectra, half lives and branching ratios of short lived β active isotopes are described. Particular attention is given to the results obtained from investigations into the β activity of ^{30}S(1.4 sec), ^{14}O(71 sec), ^{18}Ne(1.47 sec) and ^{26}Si(2.1 sec). (auth) (France)

38944 LIFETIME OF THE LOWEST 6^+ STATE IN ^{54}Fe AND E2 EFFECTIVE CHARGE. Saito, Hiroyuki- Nomura, Toru; Yamazaki, Toshimitsu (Tokyo Univ.). J. Phys. Soc. Jap.; 30: No. 5, 1252-60(May 1971).

The lifetime of the lowest 6^+ state in ^{54}Fe was measured by the $\beta^+ - \gamma$ delayed coincidence method in the decay of the 1.43 min ^{54}Co isomer. The half-life was determined to be 1.24 ± 0.04 nsec and $B(E2: 6^+ \rightarrow 4^+) = 38.9 \pm 1.3\ e^2fm^4$. Assuming pure $\pi f_{\frac{7}{2}}^{-2}$ configuration both for the 6^+ and 4^+ states in ^{54}Fe, the polarization charge of the $0f_{\frac{7}{2}}$ proton (δe_{eff}) with ^{56}Ni as a core is deduced to be 0.9 e. From comparison with theoretical calculations a contribution to δe_{eff} due to the $2\hbar\omega$ excitation of an inert core is found to be nearly the same in ^{48}Ca and ^{56}Ni. (auth)

38945 DECAY OF ^{44m}Sc AND ^{52}V. Okano, Kotoyuki; Kawase, Yoichi; Uehara, Shinichi (Kyoto Univ.). J. Phys. Soc. Jap.; 30: No. 5, 1231-5(May 1971).

Gamma rays emitted in the decay of ^{44m}Sc and ^{52}V were investigated. From the decay of ^{44m}Sc, five gamma transitions in ^{44}Ca were observed. Angular correlations of these gamma rays were consistent with the spin assignments of 2, 4 and 2 to levels in ^{44}Ca at 1156.9 ± 0.5, 2282.5 ± 0.8, and 2656.4 + 0.5 keV, respectively. In the decay of ^{52}V, four gamma rays of 935.6 ± 1.2, 1333.4 ± 0.4,and 1433.9 ± 0.6 and 1530.8 ± 0.8 keV were definitely identified. This fact supports the $J\pi = 3+$ assignment to the ground state of ^{52}V. The correspondence between levels in ^{42}Ca, ^{44}Ca and ^{52}Cr is discussed. (auth)

38946 ^{27}Al(d,α)^{25}Mg REACTION AT LOW ENERGIES. Liu, Yuen-chung; Chang, Chuen (Tsing Hua Univ., Hsinchu, Taiwan). J. Phys. Soc. Jap.; 30: No. 5, 1236-40(May 1971).

The ^{27}Al(d,α)^{25}Mg reaction was studied over the energy range E_d = 2.40 to 2.90 MeV. The relative integrated cross sections agree well with those predicted by the Hauser-Feshbach theory for the states of known spin. Probable spins were deduced for the 10th, 12th, and 13th excited states of the ^{25}Mg nucleus. The spin cut-off parameter value in this reaction was obtained to be $\sigma^2 \approx 9$. (auth)

38947 HIGH-RESOLUTION INVESTIGATION OF THE (p,n) REACTION THROUGH ISOBARIC ANALOGUE RESONANCES. Moses, J. D. (Duke Univ., Durham, N. C.; Triangle Universities Nuclear Lab., Durham, N. C.); Browne, J. C.; Newson, H. W.; Bilpuch, E. G.; Mitchell, G. E. Nucl. Phys.; A168: No. 2, 406-16(1971).

The ^{54}Cr(p,n)^{54}Mn and ^{64}Ni(p,n)^{64}Cu total neutron yields and the ^{54}Cr(p,p)^{54}Cr and ^{64}Ni differential cross sections were measured in the vicinity of the analogs of the third excited state of ^{55}Cr and the first excited state of ^{65}Ni. The total energy spread for these measurements is approximately 300-400 eV. The data are examined for an enhancement of the neutron widths of the fine-structure resonances associated with these analogue states. No enhancement of the neutron widths is observed. (auth)

38948 NOTE ON THE CROSS SECTION OF THE ^{25}Mg(τ,γ)^{28}Si REACTION. Davidson, W. F. (Australian National Univ., Canberra); Black, J. L.; Najam, M. R.; Spicer, B. M. Nucl. Phys.; A168: No. 2, 399-405(1971).

The differential cross section for the ^{25}Mg(τ,γ)^{28}Si reaction was measured at E_τ = 4.44, 6.08, 6.15 and 8.26 MeV, with a large NaI crystal spectrometer. The smallness of the observed cross section suggests that 3p-3h states play an insignificant role in explaining the "intermediate" structure observed above the ^{28}Si giant resonance in a recent study of the ^{28}Si(γ,n)^{27}Si reaction. (auth)

38949 LEVEL STRUCTURE OF ^{46}K STUDIED BY COMPARISON OF THE (d,α) REACTION ON ^{42}Ca AND ^{48}Ca. Paul, M.; Marinov, A.; Drory, Ch.; (and others) (Hebrew Univ., Jerusalem). Nucl. Phys.; A168: No. 2, 267-72(1971).

The angular distributions of some α-particle groups from the ^{42}Ca(d,α)^{40}K and the ^{48}Ca(d,α)^{46}K reactions were measured at a bombarding energy of 11.0 MeV. From comparison of the angular distributions, L-values were obtained and tentative spin assignments of the ground state and of three low-lying excited states in ^{46}K were made. The results are as follows: ground state (2^-); 0.586(4^-); 0.692(5^-); 0.890(3^-). These results are compared with other measurements and with theoretical predictions. (auth)

38950 ENERGY SPECTRUM AND DIPOLE TRANSITIONS OF ^{89}Y. Vergados, J. D.; Kuo, T. T. S. (State Univ. of New York, Stony Brook). Nucl. Phys.; A168: No. 2, 225-49(1971).

The formalism has been developed for shell-model calculations in a good isospin basis for nuclei near closed shells with N > Z. It is shown that in addition to the active shell-model configurations a number of extra particle-hole (p−h) excitations in the neutron excess orbitals must be included to guarantee good isospin. However it is shown that this causes no considerable calculational difficulty if one utilizes the properties of isospin operators. The formalism is applied to the case of ^{89}Y of isospins $T = T_0 \pm \frac{1}{2}$ (T_0 is the isospin of the closed shell). The model space includes 1 particle (1p), 2p−1h and some 3p−2h and 4p−3h excitations from the orbitals $1f_{\frac{7}{2}}$, $1f_{\frac{5}{2}}$, $2p_{\frac{3}{2}}$, $2p_{\frac{1}{2}}$, $1g_{\frac{9}{2}}$, $2d_{\frac{5}{2}}$, $3s_{\frac{1}{2}}$, $2d_{\frac{3}{2}}$, $1g_{\frac{7}{2}}$ and $1h_{\frac{11}{2}}$. The Hamiltonian matrix with realistic two-body interactions is constructed for all spins from $\frac{1}{2}$ to $11/2$ and both parities. By diagonalizing these large matrices the energy spectra for both isospins were obtained. Radiative widths for γ_0 and γ_1 dipole transitions are calculated. The results are in very good agreement with the experiment. (auth)

38951 MANY-PARTICLE SHELL MODEL CALCULATION OF ELECTROMAGNETIC TRANSITION RATES AND MULTIPOLE MOMENTS IN A = 30 TO 34 NUCLEI. Glaudemans, P. W. M.; Endt, P. M.; Dieperink, A. E. L. (State Univ., Utrecht). Ann. Phys. (N. Y.); 63: No. 1, 134-70(Mar 1971).

Many-particle shell model wavefunctions were used to calculate magnetic dipole and electric quadrupole transition probabilities and moments as well as log ft values for even-parity states in the A = 30−34 region. The calculations were performed for bare-nucleon g factors and charges; for effective g factors and charges obtained from a least-squares fit to experimental data; and for effective single-particle matrix elements obtained from an analogous fit. For the magnetic dipole transitions and moments it appeared necessary to perform separate fits for the A = 30−32 and 33−34 regions. The final best fits for strong transitions are excellent. The average deviation between theory and experiment with three effective single-particle matrix elements for M1 transitions and effective charges for E2 transitions is about 30%, only slightly larger than the average experimental error. Show cases are ^{31}Si and ^{33}S where the calculated lifetimes, branching ratios and mixing ratios (including the sign) all agree with the measured values within the experimental error. Poor fits, however, are obtained for transitions involving 1^+ states and, more generally, states for which the experimental and theoretical spectroscopic factors are in disagreement. Strong M1 transitions generally have a pronounced single-particle character (with one contribution in the matrix element predominating), whereas all E2 transitions have a collective character (many small contributions). (auth)

38952 LIFETIMES OF LOW-LYING EXCITED STATES IN ^{32}S. Renan, M. J.; Keddy, R. J. (Univ. of the Witwatersrand, Johannesburg). Nuovo Cim.; 3A: No. 2, 347-54(21 May 1971).

The lifetimes of the excited states at 2.23, 5.01, 6.23 and 9.389 MeV in ^{32}S were determined with the Doppler-shift attenuation method. The results are compared with predictions based on the collective and shell models. (auth)

XUM

38953 STUDY OF (d,α) REACTIONS ON ^{40}Ca AND ^{40}Ar. Suzuki, Katsumichi; Takahashi, Noriaki; Itahashi, Takahisa; Wakatsuki, Tetsuo (Osaka Univ.). J. Phys. Soc. Jap.; 30: No. 6, 1523-34(Jun 1971).

The nuclear structures of ^{38}K and ^{38}Cl were investigated by ^{40}Ca(d,α)^{38}K and ^{40}Ar(d,α)^{38}Cl reactions with 11.4 MeV deuterons. The excitation functions for ^{40}Ca(d,α)^{38}K reaction were obtained for the deuteron energy between 10.65 and 12.17 MeV. The angular distributions were measured on the low excited states of ^{38}K and ^{38}Cl. The zero range DWBA analysis of the angular distributions on these excited states gives the spin, parity and isospin assignments as follows, the 2.63 MeV state (4, 3 or 2)$^-$0, the 2.85 MeV state (4, 3 or 2)$^-$0 and the 3.97 MeV state (3, 2 or 1)$^+$0 for ^{38}K. Four strongly excited states are found in ^{38}Cl at 1.82, 1.99, 2.51 and 2.82 MeV and are considered to have positive parity from DWBA calculations. The spin and parity are considered tentatively to be (3)$^+$ for the 1.99 MeV state in ^{38}Cl. (auth)

38954 SPECTROSCOPY OF SOME ODD-PARITY NUCLEIC. Begzhanov, R. B. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 4, 56-64(1970). (In Russian).

Gamma angular correlations and half-lives of excited states of ^{69}Ga, ^{71}Ga, ^{77}Se, ^{79}Br, ^{81}Br, ^{97}Nb, ^{99}Tc, ^{103}Rh, ^{105}Rh, ^{107}Ag, ^{109}Ag, ^{115}In, ^{117}In, and ^{131}Cs were measured using NaI(Tl) crystals, stilbene, and plastic scintillators. Theoretical and experimental data on angular correlation coefficients were used for determining the spins and transition multipolarities. (R.V.J.)

38955 INVESTIGATION OF THE NEUTRON CAPTURE MECHANISM IN THE REACTION ^{80}Se(n,γ)^{81}Se AND THE NUCLEAR STRUCTURE OF ^{77}Se, ^{78}Se, AND ^{81}Se WITH THE HELP OF (n,γ) REACTIONS. Rabenstein, D.; Vonach, H. (Technical Univ., Munich). Z. Naturforsch.; 26a: 458-88(Mar 1971). (In German).

Gamma radiation from the capture of neutrons in natural Se and in enriched ^{78}Se and ^{80}Se was studied with different Ge(Li)-detectors, with a Ge(Li)-NaI pair spectrometer and with a Ge(Li)-Ge(Li) two-parameter γ-γ coincidence system. These measurements resulted in a considerable improvement of the level schemes of ^{77}Se, ^{78}Se and ^{81}Se. The ^{81}Se and the ^{107}Ag level schemes are compared, and the applicability of phonon-particle coupling to low-lying states of ^{81}Se is discussed. In the case of ^{77}Se, some properties may be possibly better described by the Nilsson model. It is rather clear, however, that both models can only be regarded as limited approximations and that more refined models are required for Se nuclei. The well-known, unusually small isomeric cross section ratio of ^{81}Se, and the weak population of p-single-quasiparticle states by primary transitions from the capture state ^{80}Se + n, which shows up in the measurements, may be understood by assuming a capture state containing a doorway state with a simple collective excitation. (auth)

38956 ^{79}Br AND THE EXCITED-CORE MODEL. Seetaramanath, M. N.; Narasimham, K. L.; Lackshminarayana, V. (Andhra Univ., Waltair, Ind.). Nuovo Cim.; 3A: No. 2, 259-62(21 May 1971).

The properties of the low-lying levels of ^{79}Br which arise due to the coupling of a $P_{\frac{1}{2}}$ proton to the even-even core are explained satisfactorily in the framework of the excited-core model. (auth)

38957 SCATTERING OF ALPHA PARTICLES BY ^{40}Ca. Davis, R. H. (Florida State Univ., Tallahassee). pp 21-57 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1-2, 1969. Quebec; Les Presses de l'Universite Laval (1970).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

A complex-potential-model description of the scattering of alpha particles by ^{40}Ca in the bombarding energy range 5 to 18 MeV is discussed. Phase-equivalent potentials which best represent the angular distributions at high energies are presented, and a possible means of choosing one of them is considered. Between 5 and 10 MeV bombarding energy, the introduction of a compound elastic scattering term is found to be essential. This analysis requires energy-averaging of the data. The complex-potential model has been further extended by making the imaginary part l-dependent in order to obtain satisfactory fits to energy-averaged angular distributions. The variation of the parameters throughout the entire energy range is obtained, and the significance of the statistical parameters is reviewed. (auth)

38958 POLARIZATION OF NEUTRONS FROM THE ^{40}Ca(d,n)^{41}Sc(G.S.) REACTION AT 3.8 MeV. Taylor, J. Jr.; Spalek, G.; Stammbach, Th.; Walter, R. L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Triangle Park, N. C.). pp 403-8 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1-2, 1969. Quebec; Les Presses de l'Universite Laval (1970).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

Neutron polarizations from the ^{40}Ca(d,n)^{41}Sc(G.S.) at 3.8 MeV are reported and compared to distorted-wave calculations. (auth) (Canada)

38959 NEUTRON ABSORPTION CROSS SECTION MEASUREMENTS OF MATERIALS BY MEANS OF REACTOR OSCILLATORS. Chiodi, P. L. (Agip Nucleare, Bologna); Pacini, F. Ing. Nucl.; 11: 3-10(Jan-Feb 1970). (In Italian).

The measurements made with the reactor-oscillator method on the neutron absorption cross section of Cu and Binel and measurements of the neutron absorption cross section of Binel made by comparison with natural Cu and amorphous B absorbers are described. The calculation of the spectral corrections by passing from the macroscopic cross section of effective absorption to the thermal absorption is reported. (J.S.R.)

38960 PRODUCTION OF ^{24}Na AND ^{22}Na FROM ^{27}Al BY HIGH-ENERGY PHOTONS. di Napoli, V. (Univ., Rome); Lacerenza, A. M.; Salvetti, F.; de Carvalho, H. G.; Benuzzi Martins, J. Lett. Nuovo Cim.; 1: No. 20, 835-8(15 May 1971).

Cross sections per equivalent quantum for ^{22}Na and ^{24}Na photoproduction from Al were measured for bremsstrahlung endpoint energies from 0.3 to 1 GeV. The average absolute cross sections were calculated by the photon-difference method and found to be (0.22 ± 0.02) mb for the ^{27}Al(γ,n2p)^{24}Na reaction and (0.19 ± 0.05) mb for the ^{27}Al(γ,3n2p)^{22}Na reaction. (R.W.R.)

38961 PRODUCTION OF ^{67}Cu FROM NATURAL ZINC USING A LINEAR ACCELERATOR. Marceau, N.; Kruck, T. P. A.; McConnell, D. B.; Aspin, N. (Univ. of Toronto). Int. J. Appl. Radiat. Isotop.; 21: 667-9(Nov 1970).

Millicurie quantities of copper 67 were produced by the reaction ^{68}Zn(γ,p)^{67}Cu following irradiation of natural zinc in the bremsstrahlung beam from a linear accelerator. The preparation had a half-life of 61.0 ± 0.5 hr and a specific activity of 0.5 mCi ^{67}Cu per μg Cu after separation of the ^{67}Cu from the zinc by distillation and ion exchange resin purification. (auth) (UK)

38962 CHARACTERISTIC DIFFERENCE FOR $0^+ \rightarrow 0^+$ AND $0^+ \rightarrow 1^+$ (^{3}He,p) TRANSITIONS IN THE 2s-1d SHELL. Betts, R. R. (Univ. of Pennsylvania, Philadelphia); Fortune, H. T.; Garrett, J. D.; (and others). Phys. Rev. Lett.; 26: 1121-4(3 May 1971).

The (^{3}He,p) reaction was studied on all even-even targets from ^{16}O to ^{28}Si. In all cases the $0^+ \rightarrow 0^+$ transitions exhibit a characteristic difference from the $0^+ \rightarrow 1^+$ transitions. This absence of pure L = 0, $0^+ \rightarrow 1^+$ transitions can presumably be understood in terms of configuration mixing. (auth)

38963 MEASURED (n,p) REACTION CROSS-SECTIONS AND THEIR PREDICTED VALUES AT 14.8 MeV. Prasad, R.; Sarkar, D. C. (Aligarh Muslim Univ., India). Nuovo Cim.; 3A: No. 3, 467-78(1 Jun 1971).

(n,p) reaction cross sections for some forty-five cases in the range $167 \geq A \geq 6$ were measured by the activation technique at (14.8 ± 0.5) MeV neutron energy. Measured cross sections are compared with the cross sections predicted semi-empirically by Gardner and Levkovskii. Experimental cross sections are also compared with cross-section values obtained theoretically using a shell-dependent level density. (auth)

38964 POSITIVE-PARITY STATES IN ODD-EVEN As ISOTOPES. Betts, R. R. (Univ. of Pennsylvania, Philadelphia); Pullen, D. J.; Scholz, W.; Rosner, B. Phys. Rev. Lett.; 26: No. 25, 1576-8(21 Jun 1971).

The (^{3}He,d) reaction on ^{70,72,74,76}Ge was studied at 17-MeV incident energy. In all four isotopes a $\frac{1}{2}^+$ state is observed about 600 keV above the low-lying $\frac{9}{2}^+$ isomeric state. The presence of these $\frac{1}{2}^+$ states provides a convincing argument in favor of the validity of the rotational model with prolate deformation and with strong Coriolis coupling in this region of the periodic table. (auth)

38965 GAMMA-RAY ANGULAR CORRELATION MEASUREMENTS IN ^{30}Si. Symes, R. D.; Crossfield, B. E.; Dawson, N.; (and others) (Univ. of Liverpool). Nucl. Phys.; A167: No. 3, 625-51(1971).

A particle-gamma angular correlation study using the reactions $^{30}Si(p,p'\gamma)^{30}Si$ and $^{30}Si(\alpha,\alpha'\gamma)^{30}Si$ has enabled spin and parity assignments to be made in ^{30}Si up to an excitation energy of 7.9 MeV. Major electromagnetic decay modes have been established for levels up to 8.6 MeV, the more complex cases by a proton-gamma coincidence method using the $^{27}Al(\alpha,p\gamma)^{30}Si$ reaction. Spin and parity assignments have been made for levels at 4809 (2^+), 4830 (3^+), 5230 (3^+), 5280 (4^+), 5487 (3^-), 5612 (2^+), 5951 (4^+), 6503 (2^-, 4^-), 6537 (2^+), 6745 (1^-), 6865 (2^-, 3^+), 6914 (2^+), 7044 (3^-, 5^-), 7223 (4^+), 7256 (2^+), 7610 (2^+) and 7899 keV (2^+). A new level is proposed at 7590 ± 10 keV. Multipole mixing ratios have been measured for most of the observed decay modes. The results are discussed in terms of collective and shell-model excitations. (auth)

38966 ROLL OF ISOSPINS IN (n,2n) NUCLEAR REACTIONS. Schlaeffer, W.; Hille, P. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II; 176: 311-23(1967). (In German).

By measurement of the isospin ratios of the reactions $^{35}Cl(n,2n)^{34g,m}Cl$ and $^{39}K(n,2n)^{38g,m}K$, the question of whether the isospin plays a part in (n,2n) reactions was reviewed. By comparison of the experimental values with calculations which depend on the angular momentum laws, it was shown that the isospin has no significance to the (n,2n) reaction mechanisms. (tr-auth)

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Refer also to abstracts 37404, 37439–37441, 37593, 37633, 37814, 38526, 38640, 38877, 38888, 38919, 38925, 38937, 38954, 38963, 39078, 39087, 39088, 39095–39097, 39111, 39116, 39119, and 39123.

38967 (A/CONF.49/P-841) RECENT ADVANCES IN THE UNITED STATES ON THE TRANSURANIUM ELEMENTS. Seaborg, G. T. (Atomic Energy Commission, Washington, D. C.); Crandall, J. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.); Fields, P. R. (Argonne National Lab., Ill.); Ghiorso, A. (California Univ., Berkeley. Lawrence Radiation Lab.); Keller, O. L. Jr. (Oak Ridge National Lab., Tenn.); Penneman, R. A. (Los Alamos Scientific Lab., N. Mex.). Sep 1971. 42p. (CONF-710901–54). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In the period of time elapsed since the last International Conference on the Peaceful Uses of Atomic Energy, two additional synthetic elements have been synthesized, many new isotopes of the known transuranium elements have been identified, and theories of nuclear stability have been developed which hold further prospects for creating a new family of elements in the atomic number range of 110 to 126. Highlights of transuranium research in the United States over the past few years are discussed including new elements and isotopes, the physics and chemistry of the known transuranium elements and hypothetical superheavy elements, the search for these elements in nature, and the large-scale production of transuranium elements for use in research and practical applications. (120 references) (auth)

38968 (AECL-3742) PROGRESS REPORT, JULY 1 TO SEPTEMBER 30, 1970. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 103p. (PR-P-87). Dep. NTIS (U. S. Sales Only).

Research progress at the Physics Division of Atomic Energy of Canada Limited in the period July 1 through September 30, 1970, is summarized. The programs of the nuclear physics branch, the general physics branch, the neutron physics branch, the theoretical physics branch, and the mathematics and computation branch are briefly described. (J.W.R.)

38969 (ANL-7728) PHYSICS DIVISION SUMMARY REPORT. Annual Review, 1 April 1969–31 March 1970. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 213p. Dep. CFSTI.

An overall view is presented of the research being conducted by the physics division at the Argonne National Laboratory in the following areas: experimental nuclear physics, medium-energy physics, theoretical physics, and experimental atomic physics. Papers published in the period April 1, 1969 to March 31, 1970 are listed. (D.H.M.)

38970 (ANL-Trans-883) NEW 0^+ STATES IN ^{124}Te AND ^{126}Te. Zhelev, Zh. T.; Zaitseva, N. G.; Sabirov, S. S. Translated for Argonne National Lab., Ill., from Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 1 43-7(1971). 8p. Dep. NTIS.

Beta and electron-capture decay of $^{124,126}I$ was studied by measuring the gamma and conversion-electron spectra by coincidence techniques. Spin-parity assignments and multipolarities were determined for $^{124,126}Te$. Several new energy levels were discovered. (R.W.R.)

38971 (ANU-P-513) ANNUAL REPORT, 1970. (Australian National Univ., Canberra. Dept. of Nuclear Physics). Jan 1971. 36p. Dep. NTIS (U. S. Sales Only).

The research programs are outlined in reaction mechanism studies, nuclear astrophysics, heavy ion induced reactions, isobaric analog states, radiative proton capture reactions with high resolution Ge(Li) detectors, radiative capture of complex particles, beam foil and general nuclear spectroscopy, implantation experiments of excited ions into magnetic solids, and theoretical studies of direct reactions and intermediate fission structure. Research equipment, staff and staff publications are listed. (Australia)

38972 (COO-535-620) TECHNICAL PROGRESS REPORT. (Colorado Univ., Boulder. Nuclear Physics Lab.). 1 Nov 1970. Contract AT(11-1)-535. 147p. Dep. NTIS.

ALUMINUM-27—proton reactions (p, nγ) at 16 MeV, γ spectra from, (E)
CARBON-12—helium-3 reactions (He-3, 2p) at 40 MeV, angular distributions for, (E)
CHROMIUM-50—helium-3 reactions (He-3, t) at 37 MeV, triton spectra from, (E)
—proton reactions (p, nγ) at 16 MeV, γ singles and n–γ coincidence spectra from, (E)
COBALT-54—energy-level scheme from iron-54 (p, n) reactions, (E)
COPPER-58—energy-level scheme from nickel-58 (p, n) reactions, (E)
DEUTERIUM—helium-3 elastic scattering at 25.5 MeV, angular distributions for, (E)
FLUORINE-19—helium-3 reactions (He-3, Be-7) and (He-3, Li-7) at 40.7 MeV, angular distributions for, (E)
—helium-3 reactions (He-3, Li-6) at 40.7 to 42 MeV, angular distributions and excitation functions for, (E)
IRON-54—proton reactions (p, nγ) at 16 MeV, γ singles and n–γ coincidence spectra from, (E)
—proton reactions (p, n) at 23 MeV, central–tensor force admixture for, (E/T)
MANGANESE-50—energy levels from chromium-50 (He-3, t) reactions, spin-parity assignments for, (E)
—energy-level scheme from chromium-50 (p, n) reactions, (E)
NICKEL-58—proton reactions (p, t) at 27 MeV, angular distributions for, (E)
—proton reactions (p, nγ) at 16 MeV, γ singles and n–γ coincidence spectra from, (E)
NIOBIUM-93—alpha reactions (α, nγ) at 11.8 to 13 MeV, γ spectra from, (E)
PHOSPHORUS-28—energy-level transitions from silicon-28 (p, n) reactions, (E)
PROTONS—reactions (p, nγ) with aluminum-27 at 16 MeV, γ spectra from, (E)
RADIUM-224—energy-level transition in, conversion electron subshell ratios for 84.5-keV, (E)
RUBIDIUM-87—alpha reactions (α, nγ) at 11.8 to 13 MeV, γ spectra from, (E)
RUBIDIUM-85—alpha reactions (α, nγ) at 11.8 to 13 MeV, γ spectra from, (E)
SAMARIUM-152—energy-level transition in, conversion electron subshell ratios for 121.8-keV, (E)
SILICON-27—energy-level transitions from aluminum-27 (p, n) reactions, (E)
SILICON-28—helium-3 reactions (He-3, 2p) at 40 MeV, angular distributions for, (E)
—proton reactions (p, nγ) at 23 MeV, γ spectra from, (E)
THORIUM-228—energy-level transition in, conversion electron subshell ratios for 57.5-keV, (E)
TITANIUM-46—proton reactions (p, nγ) at 16 MeV, γ singles and n–γ coincidence spectra from, (E)
TITANIUM-48—proton reactions (p, t) at 27 MeV, DWBA analysis of, (E/T)
TITANIUM-50—proton reactions (p, t) at 19, 23, and 27 MeV, DWBA analysis of, (E/T)
VANADIUM-46—energy-level scheme from titanium-46 (p, n) reactions, (E)
YTTRIUM-88—energy-level scheme from rubidium-85 (α, n) reactions, (E)
YTTRIUM-89—alpha reactions (α, nγ) at 11.8 to 13 MeV, γ spectra from, (E)
ZINC-64—proton reactions (p, t) at 27 MeV, angular distributions for, (E) (J.W.R.)

XUM

38973 (COO-1749-23) SEARCH FOR THE DOUBLE BETA DECAY OF ^{150}Nd USING A MAGNETIC SPECTROMETER-DETECTOR. Smith, Gary R. (Case-Western Reserve Univ., Cleveland, Ohio). [1970]. 68p. Dep. NTIS.

A large aperture, low resolution magnetic spectrometer-detector was designed and constructed to search for the double beta decay of ^{150}Nd. The spectrometer-detector was operated for ~750 hours in the low background environment of a salt mine, 2000 feet below ground level. Lower limits were set on the two neutrino and no neutrino decay modes. An interpretation of the results in terms of the character of the electron neutrino and lepton conservation is made. (auth)

38974 (EUR-4612, pp 9-39) RECENT DEVELOPMENTS IN TRANSURANIUM RESEARCH. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

Developments in transuranium and transactinide research are reviewed. Production and properties of Element 104 and above are discussed. Reactions that might be used to reach various projected or predicted points on the islands of stability are listed. (M.C.G.)

38975 (EUR-4612, pp 353-62) GAMMA-DOSE RATE OF ^{241}Am AFTER LONG-TERM IRRADIATION WITH REACTOR NEUTRONS. Flakus, F. N.; Weinlaender, W.; Born, H.-J. (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). (In German).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In Radiation protection problems relating to transuranium elements.

To produce ^{242}Cm, ^{241}Am is subjected to long-term irradiation with reactor neutrons. A series of fission products are thus generated, mainly from ^{241}Am and ^{242}Am, which sharply increase the gamma-dose rate of the sample. In view of the shielding measures to be taken during processing it is important to know this gamma-dose rate. Several examples are given of gamma-dose rates of samples up to 1 g of Am-241, which were irradiated for a period of several weeks in the Fr 2 and BR 2 reactors at Karlsruhe and Mol respectively. In particular, the time-dependent change of the dose rate for long periods after irradiation is given. (auth)

38976 (HMI-B-105) INVESTIGATIONS ON KNOCKOUT EFFECT: LAYER THICKNESS DEPENDENCE AND COLLISION CASCADES. Mertens, Peter (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Mar 1971. 53p. (In German). Dep. NTIS (U. S. Sales Only).

Experiments and calculations are reported on the knockout effect. A catcher foil is used to measure the knockout coefficient as a function of an emitting UO_2 layer's thickness. Some information about the mechanism is gained through electron microscopy of the irradiated layers. Collision cascades originating from uranium fission product are calculated in the Thomas-Fermi potential, and the knockout coefficient is estimated. (auth)

38977 (INR-P-967) EFFECT OF THE PIGMY RESONANCE ON THE CALCULATIONS OF THE NEUTRON CAPTURE CROSS SECTION. Brzosko, J. S.; Gierlik, E.; Soltan, A. Jr.; Wilhelmi, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 22p. Dep. NTIS (U. S. Sales Only).

Analyses were performed of the experimental cross sections of (n,γ) reactions for several nuclei (^{103}Rh, ^{127}I, ^{181}Ta, ^{197}Au) with the compound nucleus model. In the formula used for the probability of gamma ray emission from the compound nucleus, the presence of the well known giant resonance was accounted for as well as the presence of the "pigmy resonance" appearing at the energy $E_\gamma \approx 6$ MeV. The agreement with the experimental values is better than in the case when the "pigmy resonance" is neglected. The same conclusions can be drawn from the calculations of the shape of the spectrum of neutron capture and from the Γ_γ/D ratio. (auth)

38978 (INR-P-1232) THE DECAY SCHEME OF ^{232}Pa. Kaczarowski, R.; Kurcewicz, W.; Plochocki, A.; Zylicz, J. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 31p. Dep. NTIS (U. S. Sales Only).

Magnetic and semiconductor (Ge and Si) spectrometers were used to study the ^{232}Pa $\rightarrow$ ^{232}U decay scheme. The following γ lines, new with respect to the earlier data reported by Bjørnholm et al., were observed: 922.7, 1003.3, 1016.4, 1051.4, 1055.4, 1085.4, 1125.1, 1132.7 and 1164.5 keV. Conversion coefficients and multipolarity assignments were determined for several of these transitions. Due to the e-γ coincidence studies it was possible to show that the 1125.1 and 1055.4 keV Ei transitions feed respectively the 2^+ and 4^+ levels of the ^{232}U ground state band. This indicates the existence of new ^{232}U levels at 1172.8 and 1212.1 keV which are interpreted as 2^- and 3^- members of the $K^\pi = 1^-$ octupole band. Another new level is proposed at 1132.9 keV. As deduced from the $\beta-\gamma$ coincidence experiments, the β^- decay energy of ^{232}Pa is equal to 1337 ± 10 keV. The discussion of the experimental data in terms of nuclear models is concentrated on the octupole bands and their Coriolis interaction. (auth)

38979 (INR-P-1235) RELATIVE K-CAPTURE PROBABILITY IN THE UNIQUE FIRST FORBIDDEN DECAY OF ^{145}Sm. Myslek, B.; Pietrzyk, B.; Sujkowski, Z.; Szczepankowski, J. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 16p. Dep. NTIS (U. S. Sales Only).

The relative K-capture probability, P_K, for the unique first forbidden decay of ^{145}Sm to the 492.3-keV level in ^{145}Pm was measured by the coincidence method to be $P_K = 0.27 \pm 0.03$. This is compared with the theoretical values P_K(allowed) = 0.70 ± 0.03 and P_K(unique forb.) = $0.19^{+0.06}_{-0.05}$ calculated using the experimental decay energy Q = 115 ± 10 keV. (auth)

38980 (INR-P-1251) LEVELS OF ^{230}Th AND ^{230}U FED IN THE DECAY OF ^{230}Pa. Kurcewicz, W.; Strycznlewicz, K.; Zylicz, J.; (and others) (Institute of Nuclear Research, Warsaw (Poland)). 1970. 41p. Dep. NTIS (U. S. Sales Only).

The ^{230}Pa decay to levels of ^{230}Th and ^{230}U was investigated using Si(Li) and Ge(Li) spectrometers for singles-spectra measurements, and a Ge(Li) spectrometer combined with a six-gap β spectrometer or with a NaI(Tl) detector for coincidence measurements. A decay scheme is reported which is based on the present work and on earlier studies of other authors. This scheme accounts for all but one of the 50 internal transitions observed in the present investigation. The ^{230}Pa $\rightarrow$ ^{230}Th decay energy was determined at $Q_{EC} = 1315^{+15}_{-10}$ keV. For ^{230}U, the first excited 2^+ state was observed at 51.72 keV and the bandhead state of the $K^\pi = 0^-$ octupole band has been proposed at 366.5 keV. The experimental data are discussed in terms of nuclear models, with emphasis put on the problem of band-mixing effects. (auth)

38981 (IS-T-418) PHOTONEUTRON CROSS SECTION IN THE GIANT RESONANCE REGION FOR SEVERAL 82 NEUTRON ISOTONES. Johnson, Ronald Gordon (Ames Lab., Iowa). Feb 1971. Contract W-7405-eng-82. 134p. Dep. NTIS.

Cross sections for the reactions ^{138}Ba(γ,n)^{137m}Ba, ^{140}Ce(γ,n)^{139m}Ce, and ^{142}Nd(γ,n)^{141m}Nd were measured from threshold to near 25 MeV. Cross sections were extracted from bremsstrahlung-induced yield curves of the metastable-state residual radioactivity by using least-structure analysis. Peak energy and giant resonance width as well as peak and integrated cross sections are given for each nucleus. Structure in the cross section is observed in each case that is similar to that seen in the ^{141}Pr(γ,n)^{140}Pr cross section. The narrow resonances observed in these cross sections appear to have widths of 100 to 300 keV and an average spacing of approximately 800 keV. Possible correlation of the structure in the cross sections for the four 82-neutron isotones is discussed. (auth)

38982 (JAERI-1205, pp 22-7) E1 IAS IN MEDIUM WEIGHT NUCLEI. Sugawara, Masumi (Tohoku Univ., Sendai (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

The (e,e'p) data on ^{92}Mo, ^{90}Zr, ^{89}Y, ^{88}Sr, ^{116}Sn, ^{117}Sn, ^{118}Sn, ^{120}Sn, ^{122}Sn, ^{124}Sn, ^{138}Ba, ^{140}Ce, ^{142}Nd and ^{144}Sm are presented and discussed from a point of view of the isobaric analog state. Most of the proton energy spectra have two or three narrow proton peaks which correspond to the proton emission through the isobaric analog states. In the case of ^{90}Zr, they are at 7.9, 6.4 and 6.0 MeV. All of the Sn isotopes with even neutron number have the peaks around 8 MeV. The N = 82 nuclei, Ba, Ce, Nd and Sm, show two peaks around 10 and 13 MeV. The proton yield curves were also given and they have clear turnings which suggest the coherent IAS with the strong transition strength. The comparison between present data and the (γ,p) giant resonance data represents the existence of the fine structure in the giant resonances. (auth)

38983 (JAERI-1205, pp 59-62) (γ,n) REACTION NEAR THRESHOLD. Nakajima, Yutaka (Japan Atomic Energy Research Inst., Tokyo). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

The energy spectra of photoneutrons emitted from ^{208}Pb by

bremsstrahlung with end point just above the (γ,n) threshold were measured with the JAERI linear accelerator and 50-meter neutron time-of-flight spectrometer. Preliminary results are given. (auth)

38984 (JAERI–1205, pp 63-70) RECENT IMPROVEMENT IN ELECTRON SCATTERING BY NUCLEI. Torizuka, Yoshiharu; Itoh, Kohei (Tohoku Univ., Sendai (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

In recent years, there has been great improvement in the accuracy of experiments on muonic X-rays and electron scattering by nuclei. Analyses of these experiments have yielded new, more accurate charge distributions of nuclei. As a typical example, results for ^{208}Pb which has been investigated by several authors are summarized and results for ^{197}Au are also presented. Inelastic electron scattering by nuclei also has improved by development of the high intensity electron linac and the high-resolution spectrometer. For the doubly magic nucleus of ^{40}Ca, the cross sections of the electroexcitations for the odd-parity states were obtained in the momentum transfer range from 0.3 to 2.2 F^{-1}. These data were compared not only with macroscopic liquid-drop Tassie model but also with microscopic particle-hole model calculated by Gillet et al. Then, a value of the reduced transition probability B(E1) was extracted by a χ^2-fitting procedure using the transition charge density ρ_{tr} modified from the Tassie model, and another value of B(E1) was also extracted from the same data by assuming the shell-model type ρ_{tr}. Close values of B(E1) were obtained although primary forms of ρ_{tr} are quite different. (auth)

38985 (JINR–E6-5802) THREE-QUASIPARTICLE EXCITATIONS IN ^{205}At. Hagemann, U.; Neubert, W.; Peker, L. K.; Stary, F. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 8p. Dep. NTIS (U. S. Sales Only).

In the reaction $^{197}Au(^{12}C, 4\ n)\ ^{205}At$ an isomeric state with a half-life $T_{\frac{1}{2}} = 110 \pm 25$ ns, belonging to the $p(h_{\frac{9}{2}})^3$ configuration, was observed. (auth)

38986 (JINR–P6-5526) CONCLUSIONS ON THE STRUCTURE OF THE ^{153}Gd STATES DRAWN FROM THE RESULTS OF THE LIFETIME MEASUREMENTS. Vavryshchuk, Ya.; Novgorodov, A. F.; Morozov, V. A.; Muminov, T. M.; Razov, V. I.; Sazhinski, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The half-lives of the ^{153}Gd levels were measured by using the delayed $\gamma-\gamma$ and $e-\gamma$ coincidences method. Rotational band transition probabilities were calculated. The results are discussed in the framework of the Nilsson single-particle model. (auth)

38987 (LA–4566) FISSION AND CAPTURE CROSS SECTIONS OF SOME CURIUM ISOTOPES FROM THE PHYSICS 8 NUCLEAR EXPLOSION. Baybarz, R. D.; Simpson, F. B.; Ennis, M. E.; Keyworth, G. A.; Moore, M. S.; Berreth, J. R.; Brown, W. K.; Fullwood, R. R.; McNally, J. H.; Thompson, M. C. (Los Alamos Scientific Lab., N. Mex.). Dec 1970. Contract W-7405-eng-36. 173p. Dep. NTIS.

Using the nuclear explosion Physics 8 as a neutron source, the fission cross sections of ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, and ^{248}Cm were measured between 20 eV and 3 MeV. The radiative capture cross section of ^{244}Cm was determined between 20 eV and 10 keV, and the radiative capture of ^{246}Cm and ^{248}Cm was determined for several resonances in these isotopes. Tabulations of the data obtained are appended to the report. (auth)

38988 (LA-tr-71-39) SYMMETRY DEFECTS IN THE MEASUREMENT OF POLARIZATION. I. GENERAL DISCUSSON OF THE USUAL METHODS OF MEASURING POLARIZATION. Libert, J. Translated for Los Alamos Scientific Lab., N. Mex., from Nucl. Instrum. Methods; 41: 348-54(1966). 18p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 28321.

38989 (LB/G–2876) MEASUREMENT OF THE RATIO α OF RADIATIVE-CAPTURE AND FISSION CROSS-SECTIONS FOR ^{239}Pu IN THE ENERGY RANGE OF NEUTRONS 0.1-30 keV. Kononov, V. N.; Kurov, M. A.; Poletaev, E. D.; Prokopets, Yu. S.; Ryabov, Yu. V.; So Don Sik; Stavisskii, Yu. Ya.; Chikov, N. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from report JINR–P3-5112. 11p. Dep. NTIS (U. S. Sales Only).

The ratio α of the radiative capture and fission cross sections for plutonium-239 was measured by the time-of-flight method in the neutron energy range 0.1–30 keV and with a resolution of 15 and 220 ns/m. (auth)

38990 (NP–18868) ANNUAL REPORT 1970. (Grenoble Univ. (France). Institut des Sciences Nucleaires). 148p. (In French). Dep. NTIS (U. S. Sales Only).

A review is made of the various activities of the Grenoble Nuclear Science Institute, in 1970. They concern the cyclotron and its equipment, experiments made with it, radioactivity studies, experiments made in collaborations with other laboratories, and theoretical nuclear studies. (France)

38991 (NP–18874) CONTRIBUTION TO THE STUDY OF SURFACE REACTIONS BETWEEN MEDIUM-MASS-TARGET NUCLEI (Ag) AND HEAVY PROJECTILES (C,N). Galin, Joel (Paris Univ. (France). Faculte des Sciences). 1971. 93p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The mechanism of the surface reactions occurring between medium-mass target nuclei (Ag) and heavy projectiles (C,N) was studied. The natural silver targets were obtained by vacuum deposition. The experiment was performed with the ^{12}C and ^{14}N beams of the Orsay cyclotron; the ^{14}N nuclei were accelerated to 78 MeV and 113 MeV. The results concerning products formed with cross sections greater than one hundred μb were analyzed. The mass balance of the reaction was investigated for the ^{107}Ag and ^{109}Ag isotopes of the target. Sixteen nuclei were detected from the system (^{12}C + Ag) and nineteen from the system (^{14}N + Ag). The angular distributions for each of these products were established as well as the energy spectra in each measurement direction. The cross sections relating to two possible mechanisms were calculated. A quasi-elastic transfer mechanism and an inelastic mechanism involving the preferential formation of nuclei in the forward direction were studied. The critical angular momentum limiting the formation of a compound nucleus was calculated. (France)

38992 (NP–18876) THE (d,^{3}He) REACTION WITH ^{209}Bi AT 80 MeV AND THE EVEN LEAD ISOTOPES. CONTRIBUTION TO THE STUDY OF THE PHENOMENOLOGICAL NUCLEAR POTENTIALS OF ^{208}Pb. Royer, Denis (Paris Univ., Orsay (France). Faculte des Sciences). 1971. 58p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The reactions ^{204}Pb (d, ^{3}He), ^{206}Pb (d, ^{3}He) and ^{209}Bi (d, ^{3}He) were studied using the 80-MeV deuteron beam of the Orsay synchrocyclotron. The results obtained for the reactions ^{208}Pb (d, ^{3}He) ^{207}Tl and ^{209}Bu (d, ^{3}He) ^{208}Pb and also ^{204}Pb (d, ^{3}He) ^{203}Tl and ^{206}Pb (d, ^{3}He) ^{205}Tl (angular momentum and excited states) are compared. The single particle states and the phenomenological potentials of ^{208}Pb are studied. (France)

38993 (ORO–2843-18) PROGRESS REPORT [ON NUCLEAR CHEMISTRY], ANNUAL 1970. (Florida Univ., Gainesville). 76p. Dep. NTIS.

Research progress by the nuclear chemistry group at the University of Florida during 1970 is described. The research covered ternary fission, charged-particle interactions with matter, and the use of thin film detectors as dE/dx counters. (J.W.R.)

38994 (ORO–2972-189) QUANTITATIVE STUDIES OF NUCLEAR STRUCTURE THROUGH ISOBARIC ANALOG RESONANCES. Darmodjo, S.; Alders, R. D.; Martin, D. G.; Dyer, P.; Ali, S.; Zaidi, S. A. A. (Texas Univ., Austin. Center for Nuclear Studies). [1971]. 47p. Dep. NTIS.

Isobaric analog resonances (IAR) observed in the elastic scattering of protons from ^{208}Pb, ^{138}Ba, ^{124}Sn and ^{120}Sn are analyzed in the framework of the shell-model theory of reactions. Parametrization of the energy-averaged S-matrix elements given by the shell-model theory is discussed, and the dependence of the spectroscopic factors upon the various optical model parameters is exhibited. The resonance mixing phases for most of the IAR analyzed here cannot be distinguished from zero. Damping of the single-particle wave functions arising from the non-locality of the optical potentials is consistently incorporated. The non-locality length of 0.85F employed in this analysis leads to an attenuation of the single-particle wave functions by about 15% inside the nucleus. Neutron spectroscopic factors obtained here compare favorably with corresponding results from the study of (d,p) and (t,d) reactions. (auth)

38995 (RISO–M–1308) LEVEL DIAGRAM OF ^{175}Yb AND A MEASUREMENT OF THE LOW-ENERGY $^{197}Au(n,\gamma)$-SPECTRUM. Breitig, Hanns-Dieter (Danish Atomic Energy Commission, Risoe. Research Establishment). Feb 1971. 88p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Munich Univ., Ger.

The $^{174}Yb(n,\gamma)$-spectrum was measured in the energy region of 26–1500 keV. More than half the observed 129 γ-lines were placed

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in a level scheme. Precise energies were determined for the states, and their de-excitation was studied in detail. New rotational bands, with the configurations $\{([624\uparrow]_n + [512\uparrow]_n + [514\downarrow]_n)_{8^-} + [642\downarrow]\}$, $[651\downarrow]$ and $[642\downarrow]$ are proposed at 1067, 1356 and 1937 keV. Calculations show that these bands mix strongly through Coriolis coupling. Additional and previously unknown states of the [624] and [633] bands are proposed. Level energies and γ-branching ratios are explained reasonably well through a multi-band mixing calculation of the configurations with negative parity. In a measurement of the neutron-capture spectrum of ^{197}Au, 500 lines were found in the energy region of 1000-30 keV. Fifty-four of these lines are due to double capture. They allowed a confirmation of the ^{199}Au level scheme, known from the ^{199}Pt β-decay. (58 references). (auth) (Denmark)

38996 (RLO-2227-T-7-1) NUCLEAR CHEMISTRY PROGRESS REPORT, MARCH 15, 1970-MARCH 15, 1971. Loveland, Walter D. (Oregon State Univ., Corvallis). Mar 1971. Contract AT(45-1)-2227. 43p. Dep. NTIS.

BISMUTH-209—alpha fission at 35 MeV, cadmium-115 isomer ratios in, (E)
CADMIUM-115—isomer ratios in charged-particle-induced fission, (E)
CESIUM-134—isomer ratios in charged-particle-induced fission, (E)
RADIUM-226—neutron fission at 3.5 to 9 MeV, analysis for transition state structure in cross section for, (T)
—deuteron fission at 19 MeV, cadmium-115 and cesium-134 isomer ratios in, (E)
THORIUM-232—deuteron fission at 20 MeV, cadmium-115 and cesium-134 isomer ratios in, (E)
TIN-125—beta decay of, γ energies and intensities from, (E)
URANIUM-238—alpha fission at 35 MeV, cadmium-115 and cesium-134 isomer ratios in, (E) (J.W.R.)

38997 (SRRC-38/71) DETAILS OF SOME BETA HEATING CALCULATIONS. Scobie, J.; Scott, R. C. (Scottish Research Reactor Centre, East Kilbride (Scotland)). [1971]. 12p. Dep. NTIS (U. S. Sales Only).

Calculations were performed of beta energy release rates following the thermal neutron induced fission of ^{233}U, ^{235}U, ^{239}Pu and ^{241}Pu. The method of calculation is described and the input data, consisting of the independent fission yields, half-lives, average beta energies and branching ratios of the various nuclides, are tabulated. The Fortran V computer program, which enabled the calculation to be carried out on the Univac 1108 machine at the National Engineering Laboratory, is listed. (auth)

38998 (WARD-4181-1) EVALUATION OF ^{238}U NEUTRON CROSS SECTIONS FOR THE ENDF/B VERSION II FILE. Pitterle, T. A. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Mar 1971. Contract AT(30-1)-4181. 74p. Dep. NTIS.

Neutron cross sections of ^{238}U for material 1103 of the ENOF/B Version II data file were evaluated. The evaluation includes capture, fission, total, (n,xn), and elastic and inelastic scattering cross sections. The implications of measurements made since the evaluation are discussed as well as estimated uncertainties in the evaluated data. (J.W.R.)

38999 STRUCTURE OF MATTER INVESTIGATIONS BY THERMAL NEUTRONS IN ROME. Paoletti, A.; Sciuti, S. (CNEN, Rome. Istituto Fisico della Facolta di Ingegneria, Rome). pp 204-9 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

Some recent research in nuclear and solid state physics using thermal neutrons at the Casaccia Center of CNEN is briefly described. The RC-1 reactor was the source of thermal neutrons. (J.W.R.)

39000 INFLUENCE OF RESONANCE INTERACTIONS IN THE STATISTICAL RESONANCE REGION ON THE EFFECTIVE CROSS SECTIONS OF ^{238}U-^{239}Pu-MIXTURE. Pucker, N. (Univ. of Graz). Acta Phys. Austr.; 31: 209-44(Jul 1970).

The various expansions for the calculation of interaction effects due to resonances of ^{238}U and ^{239}Pu are first discussed. The resonances of both nuclei are treated as isolated. Typical resonance parameters are used; some examples show how newly obtained resonance data might affect the results. The methods for treating the overlap within a single resonance sequence are then discussed. Numerical results allow clarification of previous discrepancies concerning the influence on the self-shielding behavior of ^{239}Pu caused by the resonance properties of ^{238}U. Throughout the calculations p-wave neutrons are neglected, and interference of potential scattering and resonance scattering is considered unimportant for this problem. (R.W.R.)

39001 PRECESSION MEASUREMENTS OF THE 545 keV (6^+) ROTATIONAL STATE OF ^{148}Sm. Kugel, H. W.; Kalish, Rafael; Borchers, R. R. (Univ. of Wisconsin, Madison). Nucl. Phys.; A167: 193-200(1971).

The ion-implantation perturbed-angular-correlation technique was used to measure γ-ray angular distributions from the decay of the 545-keV (6^+) rotational state of ^{154}Sm recoiled into both copper and polarized iron. The precession angle ($\omega\tau$) measured in the polarized-iron implantation experiments is consistent with present knowledge of the transient and static magnetic hyperfine fields acting on nuclei recoiled into ferromagnetic hosts. These data and the results of previous measurements give values of $H_0 = 2.3 \pm 0.2$ MOe and $H_1\tau_1 = 10.7 \pm 9.1$ MOe · psec for the magnetic hyperfine fields at samarium nuclei recoiled into polarized iron (300°K). The g-factor ratio for the second (4^+) and third (6^+) excited states of the ^{154}Sm ground state rotational band is $g_{6^+}/g_{4^+} = 1.05 \pm 0.11$. (auth)

39002 DIRECTIONAL CORRELATION AND INTENSITY STUDIES OF ELECTROMAGNETIC TRANSITIONS IN ^{181}Ta. Avignone III, F. T. (Univ. of South Carolina, Columbia); Trueblood, J. H.; Grabowski, Z. W. Contract AT(11-1)-1746. Nucl. Phys.; A167: 129-42(1971).

Gamma-gamma directional correlations were measured in ^{181}Ta by using a 25-cm^3 Ge(Li) detector and a 7.6 cm × 7.6 cm NaI(Tl) detector. Extranuclear perturbations were avoided by dissolving the ^{181}Hf source in a solution of HF. The following correlation coefficients were measured: $A_2 = -0.295 \pm 0.005$, $A_4 = -0.069 \pm 0.008$ for the 133γ-482γ cascade; $A_2 = +0.197 \pm 0.012$, $A_4 = -0.008 \pm 0.020$ for the 133γ-(346γ)-136γ cascade; and $A_2 = +0.110 \pm 0.010$, $A_4 = 0.022 \pm 0.014$ for the 133γ-346γ cascade. The E2 internal conversion particle parameters for the 133-keV transition were determined by measuring the 133K-482γ, the 133LM-482γ, and the 133γ-482γ correlations in the same solid source. The results are $b_2(133K) = 1.79 \pm 0.11$ and $b_2(133LM) = 1.18 \pm 0.10$, which are in good agreement with theory. The following internal conversion coefficients were also measured: $\alpha_K(136) = 146 \pm 0.15$, $\alpha_K(137) = 2.2 \pm 0.6$, $\alpha_K(482) = 0.0234 \pm 0.0015$, and $\alpha_K(615) = 1.32 \pm 0.20$. The directional correlation data imply E2/M1 multipole-mixing ratios of $\delta(136) = 0.45 \pm 0.02$ and $\delta(482) = 5.8^{+0.9}_{-0.7}$. This value for $\delta(482)$ and a weighed average of the present and four previous values of $\alpha_K(482)$ are used to re-evaluate the internal conversion penetration parameter as $\lambda(482) = 175^{+7}_{-4}$. (auth)

39003 HIGH-ENERGY PHOTOFISSION OF HEAVY AND MEDIUM-HEAVY ELEMENTS. Methasiri, T.; Johansson, S. A. E. (Lund Inst. of Tech., Sweden). Nucl. Phys.; A167: 97-107(1971).

The photofission cross sections per equivalent quantum of Pb, Au, Ta, Yb, Ho, Gd, Nd, La, Sn, Ag, Mo, Cu, and Ni were measured in the bremsstrahlung energy region 300 to 900 MeV. A glass detector was used to detect fission fragments. Fission cross sections were calculated from the yield curves. It is found that the fission cross sections are constant within the investigated energy region. (auth)

39004 ENTRANCE CHANNEL INTERFERENCE EFFECT IN THE NEUTRON DECAY OF 2^+ ANALOGUE RESONANCES. Kim, H. J.; Robinson, R. L. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A167: 73-80(1971).

The angular distributions of the decay neutrons populating $\frac{1}{2}^-$, $\frac{3}{2}^-$, and $\frac{5}{2}^-$ states of ^{91}Nb and ^{95}Tc resulting from the $J^\pi = 2^+$ analog resonances induced by s- and d-wave protons are investigated. The experimental angular distributions show the interference effect arising from the coherence between the partial waves involved in the resonance. The analysis of the observation shows that it is necessary and sufficient that the interference be between the $s_{\frac{1}{2}}$ and $d_{\frac{5}{2}}$ partial waves in the entrance channel. The ratios of the spectroscopic factors and the relative signs of the reduced width amplitudes for the $s_{\frac{1}{2}}$ and $d_{\frac{5}{2}}$ protons are deduced from the data. The ratios of the spectroscopic factors agree with the (d,p) results. (auth)

39005 NUCLEAR STRUCTURE OF ^{110}Pd AND ^{116}Cd VIA THE (p,p′) AND (p,p′γ) DIRECT REACTIONS. Deye, James Alan. Nashville; Vanderbilt Univ. (1970). 185p. University Microfilms Order No. 71-10,444.

Thesis.

States in ^{110}Pd and ^{116}Cd were studied by means of the inelastic scattering of 12- and 13-MeV protons; the scattered protons were detected with a surface-barrier silicon detector. Proton energy resolution varied from 12 to 60 keV (full-width at half-maximum). In ^{116}Cd, protons scattering to 26 excited states below 3.2 MeV were observed, and the angular distributions were measured for 18 of these groups below ~2.8 MeV. Comparisons are made between the experimental distributions and those predicted by the

distorted-wave Born-approximation (DWBA) and Coupled-Channel (C.C.) theories with the collective-vibrational description used as the nuclear model. On this basis, evidence is produced for states in ^{116}Cd that have one-quadrupole and octupole, two-quadrupole, and octupole–quadrupole phonon natures. The deformation parameters (β's) are extracted. Additional information concerning both ^{110}Pd and ^{116}Cd is extracted from the $(p,p'\gamma)$ experiments. Coincident gamma rays were detected by a 3 in. × 3 in. NaI detector situated at 90° with respect to the reaction plane. These measurements result in energy-level diagrams with branching ratios for both ^{110}Pd and ^{116}Cd. These data are then correlated with the (p,p') differential cross section results for each nucleus. It is found that ^{110}Pd and ^{116}Cd, like their neighboring nuclei, exhibit a "near-harmonic" vibrational character. In addition to the one- and two-phonon states in both nuclei, five states in ^{110}Pd have the decay characteristics of three-quadrupole-phonon-type states: they exhibit preferential decay to the two-quadrupole phonon triplet rather than to the one-quadrupole phonon state. The states observed in ^{116}Cd include a previously unreported low-lying level at 1.28 MeV. Although this state is in the two-phonon energy region, it does not appear to have a collective nature. (Diss. Abstr. Int., B) (TSS)

39006 NUCLEAR MATRIX ELEMENTS AND THE CVC THEORY IN THE FIRST-FORBIDDEN BETA DECAY OF ^{76}As, ^{86}Rb, ^{122}Sb, ^{124}Sb, ^{140}La, AND ^{198}Au. Smith, Hastings Alexander Jr. Lafayette, Ind.; Purdue Univ. (1970). 188p. University Microfilms Order No. 71-9469.

Thesis.

The nuclear matrix elements for first-forbidden beta decay of ^{76}As, ^{86}Rb, ^{122}Sb, ^{124}Sb, ^{140}La, and ^{198}Au are extracted using available experimental data such as the shape correction factor, energy dependence of the directional correlation, the angular and energy dependence of the circular polarization correlation, and nuclear orientation information. The ratio of the matrix elements $\langle\vec{\alpha}\rangle$ and $\langle i\vec{r}\rangle$ is compared with the prediction based on the CVC theory. It is found that in ^{76}As, ^{86}Rb, ^{122}Sb, and ^{198}Au the ratio $\langle\vec{\alpha}\rangle/\langle i\vec{r}\rangle$ agrees with the CVC prediction based on the assumption that the nuclear Coulomb Hamiltonian is diagonal; however, in these nuclei contributions from off-diagonal matrix elements of the Coulomb Hamiltonian can not be ruled out. In ^{140}La it is found that significant off-diagonal contributions from the Coulomb Hamiltonian are necessary in order to agree with the CVC predictions. In ^{124}Sb it is concluded that higher-order matrix elements play a significant role in the formulas; and a more rigorous analysis, taking into account these higher order terms, is necessary. The beta–gamma circular polarization correlation in ^{76}As was measured and used to restrict the matrix elements for this nucleus. (Diss. Abstr. Int., B)

39007 ANGULAR ANISOTROPY OF NUCLEAR FISSION BY NEUTRONS AND THE BARRIER STRUCTURE. Androsenko, Kh. D. (Physical Energetics Inst., Obninsk, USSR); Ermagambetov, S. B.; Smirenkin, G. N.; Shpak, D. L.; Kovach, I. Acta Phys. Acad. Sci. Hung.; 29: No. 4, 341-57(1970). (In Russian).

Measurements of the angular distribution of fragments produced in the neutron-induced fission of ^{232}Th, ^{235}U, ^{237}Np, ^{238}Pu, ^{240}Pu, ^{242}Pu and ^{241}Am are reported. Particular attention is paid to excitation energies near the threshold. The experimental data do not fit the traditional picture of fission probability, but can be satisfactorily explained in terms of double-humped barrier concepts. In discussing the results, the quasi-stationary states of the nucleus in the second valley, the structure of barriers, even–odd differences in fission probability, and the question of the penetration probability at certain energies in the case of highly deformed nuclei are briefly examined. (auth)

39008 FIRST STEP TOWARD REALISTIC CALCULATIONS OF PARITY-MIXING EFFECTS IN HEAVY NUCLEI. Gari, M.; Dumitrescu, O.; Zabolitzky, J. G.; Kuemmel, H. (Ruhr-Univ., Bochum, Ger.). Phys. Lett.; 35B: 19-24(26 Apr 1971).

As an example the circular polarization of the 482 keV line in ^{181}Ta is calculated using a semi-microscopic description of the nucleus (independent particle model with the effective residual interactions of the pairing plus quadrupole and octupole types) and taking into account short-range correlations via the generalized Bethe–Goldstone equation. The results obtained for various strong and weak nucleon–nucleon potentials are far away from agreement with other calculations done up to now. No weak interaction theory seems to be able to explain the experimental values. (auth)

39009 PARITY NON CONSERVING EFFECTS IN ^{181}Ta AND ^{175}Lu. Desplanques, B.; Vinh Mau, N. (Institut de Physique Nucleaire, Orsay, France). Contract AT(30-1)-4032. Phys. Lett.; 35B: 28-30(26 Apr 1971).

The circular polarization of 482 keV transition in ^{181}Ta and 396 keV transition in ^{175}Lu was calculated. Pairing effects and short range correlations were considered. In the conventional weak interaction model the values of polarization are too small compared to the measured values. (auth)

39010 X-RAY ISOTOPE SHIFTS AND NUCLEAR RADII IN Sm. Lee, P. L.; Boehm, F. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Lett.; 35B: 33-4(26 Apr 1971).

The isotope shifts were measured for the $K\alpha_1$ x rays of six Sm isotopes. From the observations the following variations of the mean square nuclear charge radii, $\delta\langle r^2\rangle$, are obtained in units fm^2, $^{147-148}$Sm: 0.171 ± 0.010, $^{148-149}$Sm: 0.080 ± 0.008; $^{149-150}$Sm: 0.303 ± 0.010; $^{150-152}$Sm: 0.411 ± 0.012, $^{152-154}$Sm: 0.221 ± 0.013. A comparison with optical measurements is presented. (auth)

39011 LEVEL STRUCTURE STUDIES OF THE ^{74}Ge, ^{114}Cd, ^{152}Sm, AND ^{240}Pu NUCLEI, AND A FEASIBILITY STUDY OF THE $\gamma-\gamma-\gamma$ TRIPLE DIRECTIONAL CORRELATION TECHNIQUE. Coffman, Franklin Edward. Nashville; Vanderbilt Univ. (1970). 141p. University Microfilms Order No. 71-10,443.

Thesis.

Gamma-spectrum and $\gamma-\gamma$ directional-correlation measurements were performed with Ge(Li) and NaI–Ge(Li) detectors on the decay of ^{74}As. Eleven transitions from 595.7 to 2198.4 keV were observed and fitted into levels at 595.7 ± 0.1, 1204.3 ± 0.1, 1463.2 ± 1.0, 1482.6 ± 0.5, 1697.3 ± 1.0, and 2198.2 ± 0.5 keV in ^{74}Ge and 634.8 ± 0.1 keV in ^{74}Se. Directional correlation measurements were performed on the 608–596-keV, 2–2–0 cascade and on the 887–596-keV cascade. Percent feedings and log-ft values were calculated for decays to ^{74}Ge and ^{74}Se. Singles and coincidence measurements were carried out on the decay ^{114m}In–^{114}In with Ge(Li) detectors. The following transitions in keV were observed (intensities in parentheses): 558.04 ± 0.16 (102 ± 4), 575.74 ± 0.12 (0.115 ± 0.010), and 725.21 ± 0.10 (100) in ^{114}Cd and 1299.98 ± 0.12 (4.10 ± 0.25) in ^{114}Sn. Previously unreported log-ft values were derived for decays of 1^+ ^{114}In to the 1133.8-keV (0^+), 1208-keV (2^+), 1305.8-keV (0^+), and 1363-keV (2^+) levels in ^{114}Cd as 5.4, >6.9, >6.4, and >5.9, respectively. Ge(Li)–Ge(Li) multiparameter coincidence experiments and singles measurements were made of the gamma rays resulting from the decay of ^{152}Eu to search for possible $\gamma \rightarrow \beta$ interband transitions and to determine the applicability of first- and second-order band mixing to the revised decay scheme resulting from the present work. The presence of a 275.6-keV $2^+_\gamma \rightarrow 2^+_g$ interband transition was confirmed by coincidence measurements. The E2 branching ratios for transitions from the 2^+_γ and 2^+_β levels were calculated, and it was found that the branching ratios did not fit the Alaga rules. The failure of first- and second-order band-mixing techniques for the β-band and the observance of the $\gamma \rightarrow \beta$ 275.6-keV interband transitions raise serious questions about the rotational description of the β band with the axially symmetric Rotator Model. A new level at 1292.6 keV was found. It has a spin-parity of 2^+. Ge(Li)–NaI gamma–gamma directional-correlation measurements were made on the gamma-ray cascades in ^{240}Pu. The spin–parities of the 1410.8-keV and 1438.5-keV levels were determined to be 0^+ and 2^+, respectively. These spin–parity assignments establish the 1410.8-keV and 1438.5-keV levels to be the 0^+ and 2^+ members of a K = 0, two-phonon octupole band has been observed. A feasibility study was carried out on a triple gamma cascade in ^{154}Gd to test the usefulness of the $\gamma-\gamma-\gamma$ triple-correlation technique. Two detectors were in the 180° geometry, and the movable detector was rotated in the plane with these detectors. Several experimental problems were noted that make this tool of limited applicability. (Diss. Abstr. Int., B) (TSS)

39012 PRECISION ENERGY MEASUREMENTS OF GAMMA RAYS OCCURRING IN THE DECAYS OF ^{165}Dy AND ^{193}Os. Ludington, M. A.; Raeside, D. E. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods; 94: No. 1, 193(1971).

A curved-crystal spectrometer has been utilized to obtain energy measurements of 22 gamma rays between 73 keV and 715 keV occurring in the decays of ^{165}Dy($T_{\frac{1}{2}}$ = 2.4 h) and ^{193}Os($T_{\frac{1}{2}}$ = 31h). Some of these energy measurements have sufficiently small uncertainties associated with them to make them useful for the calibration of Ge(Li) spectra. (auth)

39013 NEUTRON RESONANCES OF ISOTOPES ^{136}Ce AND ^{142}Ce. Vertebnyi, V. P.; Vorona, P. N.; Kalchenko, A. I.; (and others) (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 15: 2050-3(Dec 1970). (In Russian).

Transmission of samples of natural Ce and its isotopes ^{136}Ce, ^{138}Ce, ^{140}Ce, and ^{142}Ce were measured in the energy range of 5000 eV (with resolution 0.05 ns/m) by the time-of-flight method. The ^{136}Ce energy levels 66.3 eV, 135.7 eV, 181 eV, 187 eV, 232 eV, 274 eV, 533 eV, 633 eV and 876 eV; and the ^{142}Ce levels at 1290 eV

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and 4380 eV were detected. Probably, the 1640-eV and 2740-eV levels also belong to ^{142}Ce. Neutron widths of ten levels and one of fundamental parameters of the level density parameter a are calculated. (auth)

39014 NUCLEAR DATA SHEETS FOR A = 201. Auble, R. L. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 5: 561-79(Jun 1971).

The Nuclear Data Sheets for A = 201 were last compiled in 1962. Although the volume of data accumulated since the previous compilation is relatively small, the new data are generally of very high quality and serve to establish many level energies and decay properties with high precision, particularly in ^{201}Tl. The occurrence of isomerism in ^{201}Hg, ^{201}Tl, ^{201}Bi, ^{201}Po, and ^{201}Rn has been established, in addition to the previously well-known ^{201m}Pb. Adopted level properties and decay schemes presented in the present compilation are based on data received through February 1971. (auth)

39015 NUCLEAR DATA SHEETS FOR A = 202. Auble, R. L. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 5: 581-600(Jun 1971).

Nuclear structure data from reaction and radioactivity studies on A = 202 nuclei are compiled, and adopted level properties and decay schemes are presented. The internal-conversion and lifetime data are compared with theoretical predictions to deduce gamma-ray multipolarities and level spins and parities. The level of our knowledge about the structure of these nuclei is found to have changed relatively little since the previous (1962) compilation. The present compilation includes all data available through February 1971. (auth)

39016 NUCLEAR DATA SHEETS FOR A = 204. Martin, M. J. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 5: 601-30(Jun 1971).

Detailed level schemes and the experimental reaction and decay data on which they are based are presented for all the nuclei with mass number A = 204. The experimental data are evaluated; inconsistencies and discrepancies are noted; and adopted values for level and gamma energies, gamma intensities, and other nuclear properties are given. Conclusions regarding spin assignments, as well as some configuration assignments, are presented. The level schemes for each of the A = 204 nuclei are presented first. Then, for each nucleus, there follow the experimental data and a summary of level properties, γ-ray properties, and compilers' comments. All data received before March 1971 are included. (auth)

39017 NUCLEAR DATA SHEETS FOR A = 210. Lewis, M.B. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 5: 631-63(Jun 1971).

Level schemes, spin and parity assignments, and decay properties are presented for all nuclei with mass number A = 210. Experimental data and adopted values are given along with conclusions as to the spin and parity assignments. The presentation of the nuclear properties is given in the light of the data and current theoretical ideas. Where reasonably well established, shell-model configurations are noted for some nuclei. Compilers attempt to bring out inconsistencies in the data and resolve discrepancies when possible. Level schemes for each nucleus of the A = 210 nuclei are presented first. Then, the experimental data for each nucleus are presented, usually followed by a summary of level properties and γ-ray properties. Only those references that were believed useful for compilation are given here. For other references, the reader is referred to the previous compilation (for those before 1962) and the Recent References section of Nuclear Data Sheets. Adopted level and decay properties are based on data received before February 1971. (auth)

39018 OBLATE–PROLATE TRANSITIONS IN THE FISSION OF SUPERHEAVY NUCLEI. Schultheis, H.; Schultheis, R. (Univ., Munich). Phys. Lett.; 35B: No. 4, 296-8(7 Jun 1971).

The influence of γ-deformation on fission is studied in ^{298}114. The nuclear shape changes in the vicinity of the saddle point from oblate to prolate via non-axial distortions. The effect on the spontaneous fission half-life has been considered. (auth)

39019 PROCEEDINGS OF THE ROBERT A. WELCH FOUNDATION CONFERENCES ON CHEMICAL RESEARCH. XIII. THE TRANSURANIUM ELEMENTS: THE MENDELEEV CENTENNIAL. Conference Held in Houston, Texas, November 17–19, 1969. Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970). 507p. (CONF-691124).

Separate abstracts were prepared for 11 of the 15 chapters included. One of the remaining four chapters is outside the scope of NSA and three chapters consisted of introductions and discussions rather than formal papers. (J.W.R.)

For abstracts of individual chapters see: 37337, 37396, 39020–39025, and 39093–39095.

39020 FROM MENDELEEV TO MENDELEVIUM: AND BEYOND. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). pp 5-40 of Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research. XIII. /Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970).

From Robert A. Welch Foundation conferences on chemical research. XIII. The transuranium elements; Houston, Tex. (17 Nov 1969). See CONF-691124.

Some of the events which have occurred during the last hundred years that have led to our present concept of the periodic table are reviewed, and some predictions concerning the future of the periodic table are outlined. Topics discussed include the evolution of the periodic table, electronic structure of transactinide elements, nuclear stability of superheavy elements, searches for superheavy elements in nature, methods for synthesis of superheavy elements, and some unusual periodic tables. (J.W.R.)

39021 BERKELEY HILAC HEAVIEST ELEMENT RESEARCH PROGRAM. Ghiorso, Albert (Univ. of California, Berkeley). pp 107-50 of Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research. XIII. /Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970).

From Robert A. Welch Foundation conferences on chemical research. XIII. The transuranium elements; Houston, Tex. (17 Nov 1969). See CONF-691124.

Research on the synthesis of new transactinide elements at Lawrence Radiation Laboratory is discussed. Described in detail are target materials used in heavy ion bombardment, some problems encountered in the search for new elements, the element 104 alpha emitters, first aqueous chemistry of element 104, and attempts to find the reported fractional-second spontaneous-fissioning isotope of element 104. (J.W.R.)

39022 TRANSMENDELEVIUM AND SUPERHEAVY ELEMENTS IN LABORATORY AND NATURE. Zvara, I. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 153-85 of Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research. XIII. /Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970).

From Robert A. Welch Foundation conferences on chemical research. XIII. The transuranium elements; Houston, Tex. (17 Nov 1969). See CONF-691124.

Experimental research on transmendelevium and superheavy elements at the Joint Institute of Nuclear Research is described. The work includes the synthesis and investigation of transmendelevium elements using heavy ion reactions, the synthesis of superheavy nuclei with the use of heavy ion beams, and searchs for superheavy elements in nature. (J.W.R.)

39023 25th ANNIVERSARY OF THE DISCOVERY OF AMERICIUM AND CURIUM ELEMENTS 95 AND 96: 25 YEARS AGO. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). pp 223-41 of Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research. XIII. /Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970).

From Robert A. Welch Foundation conferences on chemical research. XIII. The transuranium elements; Houston, Tex. (17 Nov 1969). See CONF-691124.

A historical account of the research leading to the discovery of americium and curium is presented. (J.W.R.)

39024 ACTINIDE AND TRANSACTINIDE ELEMENTS PRODUCTION AND RESEARCH AT OAK RIDGE. Keller, O. L. Jr. (Oak Ridge National Lab., Tenn.). pp 245-87 of Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research. XIII. /Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970).

From Robert A. Welch Foundation conferences on chemical research. XIII. The transuranium elements; Houston, Tex. (17 Nov 1969). See CONF-691124.

The experimental facilities at High Flux Isotope Reactor and the Transuranium Processing Plant of Oak Ridge National Laboratory for production and study of actinide and transactinide elements are described. In addition, the activities of the Transuranium Research Laboratory are briefly surveyed. (J.W.R.)

39025 HEAVY ELEMENT SYNTHESIS BY PROMPT MULTIPLE NEUTRON CAPTURE. Cowan, George A. (Los Alamos Scientific Lab., N. Mex.). pp 291-304 of Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research. XIII. /Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970).

From Robert A. Welch Foundation conferences on chemical

research. XIII. The transuranium elements; Houston, Tex. (17 Nov 1969). See CONF-691124.

Processes involving prompt multiple neutron capture and resulting in the synthesis of heavy elements are discussed. Predictions of isotopic abundances made according to the r-process are examined. Some experimental studies on multiple neutron capture following nuciear explosions are surveyed. (J.W.R.)

39026 NONEXISTENCE OF ISOMERIC α DECAY IN ^{154}Dy. Gono, Yasuyuki; Hiruta, Kotaro (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 30: No. 5, 1241-2(May 1971).

The enhanced alpha decay of ^{154m}Dy was reinvestigated. The alpha particles emitted from the ground states of ^{154}Dy (10^6 y) and ^{155}Dy (6.8 h) were detected from the same source. However, the alpha particles of 3.37 MeV which had been reported to be an isomeric alpha decay in ^{154}Dy (13 h) were not observed. (auth)

39027 LEVELS OF ^{117}In FROM THE ^{116}Cd(^{3}He,d)^{117}In REACTION. Ishimatsu, Toshiyuki; Nakagawa, Takemi; Orihara, Hikonojo; (and others) (Tohoku Univ., Sendai). J. Phys. Soc. Jap.; 30: No. 6, 1519-22(Jun 1971).

The ^{116}Cd(^{3}He,d)^{117}In reaction was studied with a 25.07 MeV ^{3}He beam. The l values and spectroscopic strengths were determined for ten levels up to 2.0 MeV excitation. Strong l = 0 and 2 transitions were observed against the simple shell-model expectation. These transitions are compared with predictions of the rotational model proposed by several authors, and significant disagreements are found. (auth)

39028 MEASUREMENT OF THE ENERGY OF GAMMA RADIATION FROM ^{138}Cs. Bechemilh, J. P.; Le Meur, R.; Poux, C. (Service d'Electronique des Reacteurs, Saclay, France). Nucl. Instrum. Methods; 93: No. 3, 509-13(1971). (In French).

Ge(Li) gamma spectrometry is used to determine gamma-ray energies and intensities of fission products. Experimental devices are shown including reactor loops, electronics, and programs for analysis of spectra. Gamma energies and relative gamma intensities of ^{138}Cs were measured. The principal photopeaks are: 1435.9 ± 0.2 keV, 462.8 ± 0.1 keV and 1009.8 ± 0.2 keV. (auth)

39029 VALIDITY OF ALEXANDER AND SIMONOFF'S SEMIEMPIRICAL RULE IN THE REGION $100 \leq A \leq 150$. Neubert, W. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 93: No. 3, 473-5(1971).

Alexander and Simonoff's semiempirical rule concerning the maximum position of the cross section for (H. I., xn) reactions is checked. The validity of this relation in the medium mass region $100 \leq A \leq 150$ is shown on the basis of 19 well established excitation functions. (auth)

39030 EVIDENCE FOR PARTICLE INSTABILITY OF ^{10}He. Artukh, A. G.; Avdeichikov, V. V.; Gridnev, G. F.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; A168: No. 2, 321-7(1971).

The cross section for ^{10}He production in the reaction ^{232}Th(^{15}N−5 protons) → ^{10}He at $E_{lab}(^{15}N)$ = 145 MeV was estimated from the systematics of the cross sections for multinucleon transfer reactions. In the experiment in which, assuming the particle stability of ^{10}He, about 80 ^{10}He events should be expected not even a single one was observed. This result is interpreted as evidence for the particle instability of ^{10}He. (auth)

39031 ABSOLUTE NEUTRON YIELDS AND ENERGY SPECTRA FROM 18 TARGETS BOMBARDED BY 55 AND 85 MeV BREMSSTRAHLUNG. Kaushal, N. N.; Winhold, E. J.; Augustson, R. H.; Yergin, P. F.; Medicus, H. A. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Nucl. Energy; 25: 91-100 (Feb 1971).

Absolute neutron yields and energy spectra are presented for 18 targets bombarded by 55 and 85 MeV bremsstrahlung. The yields fall off strongly with increasing neutron energy. Between neutron energies of 2 and 20 MeV, the yield falls by a factor of about 1000 in the heavy nuclei and about 30 in the light nuclei. For neutron energies of a few MeV, the yields divided by target mass number A increase strongly with A, whereas this trend is reversed for neutrons above 10 MeV. The implication of these results for neutron production targets is discussed. (auth) (UK)

39032 EVIDENCE FROM 62 MeV PROTON SCATTERING FOR EXTENDING THE WEAK COUPLING MODEL IN ^{209}Bi. Bertrand, F. E.; Lewis, M. B. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A168: No. 2, 259-66(1971).

The reaction ^{209}Bi(p,p′) was studied at a bombarding energy of 61.7 MeV. Differential cross sections were obtained between 15 and 75° for various groups of collective levels in ^{209}Bi and for the 1.62 MeV single-particle level. The data were compared with DWBA calculations, and the L-values and deformation parameters so determined were compared with those for corresponding excitations in ^{208}Pb. The results are consistent with the excitation of at least six core- (^{208}Pb) excitation multiplets in ^{209}Bi. The observed angular distribution for excitation of the 1.62 MeV level indicates a small L = 3 + (5) admixture in this predominantly $i_{9/2}$ proton state. (auth)

39033 MEASUREMENT OF THE ^{140}La FISSION PRODUCT YIELD FOR FISSIONS IN ^{238}U IN A THERMAL REACTOR TYPE SPECTRUM. Diercksx, R.; Maracci, G.; Rustichelli, F. (CCR, Ispra, Italy). J. Nucl. Energy; 25: 85-9(Feb 1971).

Although the ^{140}La fission product yield for ^{235}U is well known, a large uncertainty up to 15% exists for the absolute ^{140}La fission product yield of ^{238}U, a relative measurement of the ^{140}La fission product yield ratio of ^{238}U to ^{235}U is reported. The measurement was performed using irradiations in a back-to-back fission chamber in the Ispra-I reactor. With this chamber two U deposits may be placed in the same neutron flux, with two U foils between them. The two deposits and foils have different but known isotopic composition in ^{238}U and ^{235}U. During the irradiation the fissions occurring in the deposits are directly counted. After 2 weeks the 1.60 MeV γ-ray from ^{140}La in the two foils is counted. For the elimination of the background counts, two different counting techniques were used; a coincidence method and direct scintillation spectrometry. Data are reported for the two counting techniques in a thermal type reactor spectrum. (auth) (UK)

39034 TRAJECTORY CALCULATIONS FOR α-PARTICLE-ACCOMPANIED SPONTANEOUS FISSION. Musgrove, A. R. de L. (Australian Atomic Energy Commission Research Establishment, Sutherland). Aust. J. Phys.; 24: No. 2, 129-38(Apr 1971).

Monte Carlo calculations were made of the energy and angular distributions of the α-particle emitted in the α-particle-accompanied fission of ^{252}Cf. Classical mechanics and a three point-charge model of the scissioning nucleus were used. Good agreement with experimental distributions is obtained with an interfragment separation at scission of 23.70 f where the heavy fragment has a velocity of 3.75×10^9 cm sec^{-1}. The average initial energy of the α-particle is found to be 2.75 MeV. This set of initial parameters is intermediate between those found by Boneh, Fraenkel, and Nebenzahl and by Raisbeck and Thomas. (auth)

39035 ENERGY LEVELS OF ^{168}Tm. Jones, H. D.; Sheline, R. K. (Florida State Univ., Tallahassee). Ann. Phys. (N. Y.); 63: No. 1, 28-52(Mar 1971).

Fifty-one levels in ^{168}Tm were observed up to an excitation energy of 1514 keV utilizing 12-MeV deuterons and the reaction ^{169}Tm(d,t)^{168}Tm. The Q value of the lowest observed state was determined to be −1776 ± keV. The spectrum below 700 keV was interpreted in terms of the coupling of the [411↓] Nilsson proton orbital with the neutron orbitals prominent in the low-energy (d,t) spectrum of ^{167}Er. This interpretation resulted in the determination of relative energies due to the residual neutron−proton interaction for six different configurations. The observed singlet-triplet splitting energies for the [633↑], [521↓], and [512↑] neutron orbitals coupled to the [411↓] proton orbital were measured to be −157, +191, and −234 keV, respectively. Theoretical calculations of these energies made for a zero range spin-dependent central potential gave values of −87, +154, and −255 keV, respectively. The good agreement indicates that the spin−spin interaction can account for most of the singlet-triplet splitting energy. (auth)

39036 INTENSITIES OF ^{177}*Lu CONVERSION ELECTRONS. Kartashov, V. M.; Troitskaya, A. G.; Shevelev, G. A. (Inst. of Nuclear Physics, Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 34: 1145-7(1970). (In Russian).

The electron internal conversion spectrum in the 155-day decay of ^{177m}Lu was studied using a β spectrometer with double focusing electron beam at $\pi\sqrt{2}$ angle and pulse resolving power from 0.12 to 0.06%. The sources were prepared by separating lutetium from the tantalum target. Tabulated data are given on the relative intensities of conversion electron transitions in ^{177}Lu and ^{177}Hf. Data obtained were correlated with published data. (R.V.J.)

39037 NUCLEAR SPECTROSCOPY STUDIES IN ^{131m}Xe AND ^{125}Sb. Abdulla, Ali A. Stillwater, Okla.; Oklahoma State Univ. (1969). 76p. University Microfilms Order No. 70-21,335. Thesis.

^{131m}Xe: Second order transitions were investigated. Use was made of a conventional fast-slow coincidence circuit with optimum resolving time of 175 nanoseconds and the coincidence spectrum was analyzed and stored in a multichannel analyzer, tran-

sistorized type, with 4096 channels. ^{125}Sb: A high resolution germanium detector was used, to determine the energy levels and to look for any possible new level suspected by others. In addition, measurements of angular correlation between the 0.320 MeV and the 0.176 MeV gamma cascade were carried out with a view to solve the discrepancy regarding the spin assignment of the 0.320 MeV level in ^{125}Te a product of ^{125}Sb decay. ^{131m}Xe: It was shown that the simultaneous emission of two K-quanta cannot exceed 7.5 10^{-5} per decay. These double K-quanta result from the double K-conversion or from the internal conversion of an internal Compton effect. From the measurements described an upper limit for the W_{ekek}/W_γ can be deduced as $\leq(4.1 \pm 0.8) \cdot 10^{-3}$. ^{125}Sb: A precise measurement of the gamma energies was made. No positive evidence for a new level was found. Further a 0.652 MeV ground state transition reported in the literature was not observed. The angular correlation measurements support the assignment of $^3/_2^-$ spin for the 0.320 MeV level in ^{125}Te. (Diss. Abstr. Int., B)

39038 TERNARY FISSION OF ^{232}Th. Roginski, Thomas Charles. Lafayette, Ind.; Purdue Univ. (1970). 165p. University Microfilms Order No. 71-2679.

Thesis.

The ternary fission of ^{232}Th induced by 41-MeV ^{4}He ions was studied. Cross sections for the formation of the ternary fission products ^{24}Na, ^{28}Mg, ^{31}Si and ^{38}S and for the binary fission products ^{56}Mn, ^{66}Ni, and ^{72}Zn were determined. Upper limits were obtained for the production of ^{47}Ca and ^{199}Au. Recoil range data were obtained for ^{28}Mg which were similar to those obtained in the ternary fission of ^{238}U with ^{4}He ions. A mass yield curve for the ternary products shows a constant increase in fission cross section with decreasing mass. This trend differs from the ^{238}U ternary fission induced by ^{3}He and ^{4}He which show a change in slope at the lower mass ternary products. The production of ^{28}Mg from ^{232}Th irradiated with 36 MeV protons was also studied. Recoil studies showed that some of the ^{28}Mg was produced by spallation reactions on impurities. A preliminary value for the yield of ^{38}S was obtained from ^{232}Th irradiated with ^{3}He ions. Preliminary values for cross sections were also obtained for ^{28}Mg and ^{38}S formed from ^{235}U irradiated with ^{4}He and ^{3}He ions. (Diss. Abstr. Int., B)

39039 ABSOLUTE SPIN ASSIGNMENTS OF ^{161}Dy AND ^{163}Dy NEUTRON RESONANCES AND THE HYPERFINE COUPLING CONSTANTS IN ^{163}Dy. Brunhart, G.; Postma, Hans; Rorer, D. C.; Sailor, V. L.; Vanneste, L. (Brookhaven National Lab., Upton, N. Y.). Z. Naturforsch.; 26a: 334-42(Mar 1971).

A method and equipment are described for measuring the spin dependence of slow neutron cross sections. The neutron beam from the High Flux Beam Reactor (HFBR) is polarized by Bragg reflection from a magnetized 92% Co-8% Fe single crystal which process also serves to select the neutron energy. Nuclei in the target are statically polarized in a field of ~35 kOe at temperatures ranging from 0.05 to 0.10 K. Large nuclear polarizations are obtained in polycrystalline ferromagnetic dysprosium metal because of the large magnetic hyperfine interaction. The total angular momenta, J, of the compound states corresponding to the first several resonances in ^{161}Dy and ^{163}Dy were determined by measuring the transmission of the target with the neutron beam alternately polarized parallel and antiparallel to the nuclear polarization. Quantitative results at two resonances of opposite spin permit absolute J-value assignments (i.e., the assignments are independent of any knowledge of the absolute signs of the nuclear magnetic moments). The hyperfine interaction constants for ^{163}Dy, obtained by measuring the nuclear polarization as a function of temperature, were $A/k = 0.100 \pm 0.005$ K, and $P/k = 0.008 \pm 0.001$ K where A and P are, respectively, the magnetic and the electric hyperfine interaction constants. (auth)

39040 NUCLEAR LEVEL SCHEME OF ^{175}Yb. Breitig, Dieter (Technical Univ., Munich. Danish Atomic Energy Commission, Risoe). Z. Naturforsch.; 26a: 371-90(Mar 1971). (In German).

The Yb174 (n,γ)-spectrum has been measured in the energy region of 26 to 1500 keV. More than half of the observed 239 γ-lines were placed in a level scheme. Precise energies have been determined for the states and their deexcitation has been studied in detail. New rotational bands, with the configurations $\{([624\uparrow]_n + [512\uparrow]_n + [514\downarrow]_n)_{\frac{9}{2}} + [642\downarrow]\}$, $[651\downarrow]$ and $[642\downarrow]$ are proposed at 1067, 1356, and 1937 keV. Calculations show that these bands strongly mix through Coriolis coupling. Additional and previously unknown states of the $[624\uparrow]$ and $[633\uparrow]$ bands are proposed. Level energies and γ-branching ratios are explained reasonably well through a multiband mixing calculation of the configurations with negative parity. (auth)

39041 HIGH-ENERGY CONVERSION ELECTRONS AND THE LEVEL SCHEME OF ^{200}Hg. Mampe, W.; von Egidy, T.; Kaiser, W.; Schreckenbach, K. (Technical Univ., Munich). Z. Naturforsch.; 26a: 405-18(Mar 1971). (In German).

Approximately 165 conversion electron lines from slow neutron capture in ^{199}Hg have been measured with the beta spectrometer at the reactor FRM between 900 keV and 8 MeV. The high-energy K-conversion coefficients of E1 and M1 transitions are separated distinctly and agree very well with recent theoretical calculations. High-energy L-conversion electron coefficients have been measured for the first time with such a degree of accuracy that different multipole orders are separated and a comparison with theoretical values is possible. 6 known levels above 2 MeV have been assigned 1^+ and 14 new levels have been established. 145 lines have been placed into the level scheme and new level energies have been calculated. A new 0^+ level has been found at 1856.97 ± 0.1 keV. (auth)

39042 SUDDEN NUCLEAR CHARGE CHANGE AS AN EXCITATION MECHANISM FOR OPTICAL TRANSITIONS. Luchner, K.; Parsche, H.; Micklitz, H. (Technical Univ., Munich). Z. Naturforsch.; 26a: 423-31(Mar 1971). (In German).

The sudden change of nuclear charge (β-decay) produces a finite probability for the excitation of the outer electron shell. The emission spectrum of a gaseous ^{133}Xe-source exhibits light from the daughter Cs^+, excited by the sudden change of nuclear charge, as shown by a spectral analysis. The probability for this excitation, $p \sim 6.10^{-2}$ per β-decay, is found in coincidence with the β-particles from the upper part of the β-spectrum; this value is lowered if also the low-energy part of the β-spectrum is included in observation; this seems to indicate a breakdown of the sudden approximation around 20 keV. The absolute values of p for ^{85}Kr and ^{133}Xe are discussed. The photon yield from the ^{85}Kr-decay in solid state for high E_β is not a constant, as it is in the gaseous state, but decreases with E_β, suggesting nonradiative transitions induced by the β-recoil. (auth)

39043 PRECISE MEASUREMENT OF THE TOTAL REACTION CROSS SECTIONS OF BISMUTH, LEAD, SILICON, AND CARBON FOR 130-eV NEUTRONS. Dilg, W.; Vonach, H. (Technical Univ., Munich). Z. Naturforsch.; 26a: 442-50(Mar 1971). (In German).

A precise transmission measurement of the cross sections of bismuth, lead, silicon, and carbon for 130-eV neutrons (Co-resonance) has been carried out. A new resonance method has been applied, using epithermal reactor neutrons, which have been scattered twice from Co foils. The following total 130-eV cross sections were obtained: Bi: 9.182 ± 0.007 b, Pb: 11.295 ± 0.009 b, Si: 2.0442 ± 0.0018 b, C: 4.746 ± 0.007 b. From these results the coherent nuclear scattering lengths (bound), Bi: 8.646 ± 0.005 fm, Pb: 9.524 ± 0.004 fm, C: 6.660 ± 0.006 fm, have been calculated, with consideration of various corrections (absorption, Schwinger-scattering, incoherence, neutron–electron interaction, energy-dependence of nuclear scattering). (auth)

39044 INVESTIGATION ON THE PRIMARY SPINS OF THE ^{235}U FISSION FRAGMENTS. Armbruster, P.; Labus, H.; Reichelt, K. (Kernforschungsanlage, Juelich, Ger.). Z. Naturforsch.; 26a: 512-22(Mar 1971).

The prompt γ radiation emitted in ^{235}U thermal fission has been investigated in a multiparameter experiment. γ yield, time distribution, energy spectrum, and nuclear anisotropy of the emission have been measured, especially γ yield and anisotropy as a function of fragment mass and γ energy. The mass dependence of the primary spins of the fragments can be deduced from these measurements. A value of 7 $\hbar$ for the average primary spin and an increase of the primary spins within each fission product group is obtained. This dependence is explained within an adiabatic model of scission due to the mass dependence of the deformation of the fragments. (auth)

39045 HALF-LIVES OF ^{95}Zr, ^{103}Ru, AND ^{141}Ce. Debertin, K. (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Naturforsch.; 26a: 596-7(Mar 1971). (In German).

Measurements of the half-lives by means of a Ge(Li) detector lead to the following results: for ^{95}Zr, $T_{\frac{1}{2}} = 63.98 \pm 0.06$ days; for ^{103}Ru, $T_{\frac{1}{2}} = 39.35 \pm 0.05$ days; and for ^{141}Ce, $T_{\frac{1}{2}} = 32.51 \pm 0.06$ days. (auth)

39046 ELECTRIC-QUADRUPOLE ISOMERS IN ^{90}Nb AND ^{92}Tc. Holland, R. E.; Lawson, R. D.; Lynch, F. J. (Argonne National Lab., Ill.). Ann. Phys. (N. Y.); 63: No. 2, 607-12 (Apr 1971).

The rates of electric-quadrupole transitions between low-lying states of ^{90}Nb and ^{92}Tc were observed to be much slower than the

single-particle estimate. This inhibition can be understood if there is near-equality of the effective charge for a $g_{\frac{9}{2}}$ proton and a $g_{\frac{9}{2}}$ neutron hole. (auth)

39047 COULOMB EXCITATION OF ^{197}Au AND A CORE-EXCITATION ANALYSIS. McGowan, F. K.; Milner, W. T.; Robinson, R. L.; Stelson, P. H. (Oak Ridge National Lab., Tenn.). Ann. Phys. (N. Y.); 63: No. 2, 549-61(Apr 1971).

Additional results for magnetic-dipole and electric-quadrupole transition moments were obtained from the Coulomb excitation of ^{197}Au by ^{4}He and ^{16}O ions. The accuracy of earlier results from the Coulomb-excitation reaction is improved. The measurements include γ-ray yields, γ-ray angular distributions, and γ−γ coincidence spectra. The reduced E2 and M1 transition probabilities for all transitions among the low-lying levels $\frac{3}{2}^+$ (ground state), $\frac{1}{2}^+$ $(\frac{3}{2}^+)_2$, $\frac{5}{2}^+$, $\frac{7}{2}^+$ are compared with the predictions of de Shalit's core−excitation model of the nucleus [Phys. Rev., 122: 1530(1961)]; in particular, the data from the intramultiplet transitions provide a more stringent quantitative test of the core−excitation model. The electromagnetic properties for ^{197}Au are described rather well by the model. The model parameters for the core state are found to have values that are in accord with the experimental data for the electromagnetic properties of the 2^+ state in the neighboring even-A nuclei. (auth)

39048 CALCULATION OF INTERACTION CROSS SECTIONS ACCORDING TO A STATISTICAL MODEL WITH CONSIDERATION OF ANGULAR MOMENTUM AND PARITY CONSERVATION. Uhl, M. (Institut fuer Radiumforschung und Kernphysik, Vienna). Acta Phys. Austr.; 31: 245-70(Jul 1970). (In German).

Based on general equations for statistical models of nuclear reactions and on gamma-cascade models, a computer program was developed for the determination of interaction cross sections and isomer ratios for nuclear reactions. Two characteristic interaction cross sections, for the reactions ^{197}Au(n,2n)^{196}Au and ^{56}Fe(n,p)^{56}Mn, were calculated as function of beam energy and compared with experimental data. The calculated cross sections agree satisfactorily with the level-density parameter reported in the literature for the mass region under consideration. To obtain further conclusions, larger numbers of data must be treated because of the fact that results obtained with statistical models depend on many parameters, such as level-density parameter, transmission coefficients, and gamma decay ranges. (tr-auth)

39049 OBSERVATION OF 1.5% PARITY-NONCONSERVING γ-RAY ASYMMETRY. Krane, K. S.; Olsen, C. E.; Sites, James R.; Steyert, W. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 26: No. 25, 1579-81(21 Jun 1971).

The angular distribution of the 501-keV γ radiation from low-temperature polarized ^{180m}Hf was found to exhibit a very large parity-nonconserving forward−backward asymmetry. At a polarization of 71%, the measured asymmetry is −(1.49 ± 0.25)%. This asymmetry corresponds to an E2/M2 mixing ratio of magnitude 0.038 ± 0.007, in fairly good agreement with circular-polarization experiments. The E3/M2 mixing ratio is deduced to be +6.0 ± 0.5; this value agrees with angular-correlation measurements. (auth)

39050 SOME ASPECTS ON THE MAGNETIC-DIPOLE MOMENTS OF STATES IN NEAR-SPHERICAL NUCLEI. Bhattacherjee, S. K. (Tata Inst. of Fundamental Research, Bombay). Ann. Phys. (N. Y.); 63: No. 2, 613-48(Apr 1971).

The recently measured magnetic dipole moments of states in spherical nuclei are discussed in terms of predictions of current nuclear models. The highlights of the recent advances in the technique of measuring the g factors of nuclear states with lifetimes of the order of a few milliseconds to a picosecond are reviewed. The measured moments in several states in and around ^{208}Pb can be easily explained in terms of simple shell-model considerations using effective moments from ^{209}Bi and ^{207}Pb. The core−excitation model is examined in terms of its success in predicting the known static moments of states in some odd-A nuclei. The systematics of the empirical data on the g factors of the first 2^+ states in doubly even spherical nuclei are discussed in terms of current microscopic theories. The finding of an interesting regularity that has been observed in the magnetic moments and beta-decay Gamow−Teller matrix elements in mirror nuclei in the sd shell is reviewed. (auth) (124 references)

39051 ENERGY SPECTRUM OF DELAYED NEUTRONS FROM THE SPONTANEOUS FISSION OF ^{252}Cf. Chulick, E. T. (Washington Univ., St. Louis); Reeder, P. L.; Bemis, C. E. Jr.; Eichler, E. Nucl. Phys.; A168: No. 2, 250-8(1971).

The energy spectrum of delayed neutrons from the spontaneous fission of ^{252}Cf was measured using a time-of-flight neutron spectrometer. The experimental timing conditions emphasized delayed neutrons of about 2 s half-life. Eleven peaks due to monoenergetic neutrons were observed in the energy range from 95 to 430 keV. (auth)

39052 NOTE ON THE PROMPT-FISSION-NEUTRON SPECTRA OF ^{235}U AND ^{239}Pu. Smith, A. B. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 44: No. 3, 439-42(Jun 1971).

Prompt-neutron spectra following neutron fission of ^{239}Pu and ^{235}U were measured at 35 and 400 keV at eight angles from 25 to 155°. The relative ratio of ^{239}Pu fission neutrons to those of ^{235}U was determined as a function of fission-neutron energy from 0.3 to 8.0 MeV; the weighted value found from several different detectors was 1.075. The shape of the prompt-fission-neutron spectrum of ^{235}U to 1.6 MeV was determined; it is consistent with a Maxwellian distribution with a temperature of about 1.3 MeV. (R.W.R.)

39053 APPLICATION OF THE INTERMEDIATE-COUPLING UNIFIED NUCLEAR MODEL TO THE ODD-MASS Ag ISOTOPES. Gujrathi, S. C. (Simon Fraser Univ., Burnaby, B. C.); Pathak, B. P. Lett. Nuovo Cim.; 1: No. 22, 887-92(29 May 1971).

The intermediate-coupling approach of the unified model is used to investigate the properties of the odd-parity levels in ^{107,109,111}Ag, and the results are compared with experimental data. After a brief description of the theoretical calculation, energy-level diagrams, electric-quadrupole transition probabilities, quadrupole deformation parameters of excited states, ground-state magnetic-dipole moments, and relative spectroscopic factors for single-proton pickup reactions are presented. (R.W.R.)

39054 REACTION MECHANISM FOR p-WAVE NEUTRON CAPTURE IN ^{92}Mo AND ^{98}Mo. Mughabghab, S. F.; Chrien, R. E.; Wasson, O. A.; Cole, G. W.; Bhat, M. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 26: 1118-21(3 May 1971).

A study of γ-ray intensities following neutron capture in ^{92}Mo and ^{98}Mo provides evidence for a simple reaction mechanism that dominates the decay of the compound-nucleus state. The intensities are largely accounted for by the motion of a valency neutron in transitions of the type $p_{\frac{1}{2}} \rightarrow d_{\frac{3}{2}}$, $d_{\frac{3}{2}}$, or $s_{\frac{1}{2}}$ and the type $p_{\frac{3}{2}} \rightarrow s_{\frac{1}{2}}$ or $d_{\frac{5}{2}}$. (auth)

39055 EVALUATION OF THE NUMBER OF NEUTRONS PER FISSION FOR THE PRINCIPAL PLUTONIUM, URANIUM, AND THORIUM ISOTOPES. Davey, W. G. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Sci. Eng.; 44: No. 3, 345-71(Jun 1971).

Experimental values (apart from thermal-neutron data) of the number of prompt neutrons per fission ($\bar{\nu}_p$) for ^{232}Th, ^{233}U, ^{234}U, ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, and ^{241}Pu over the energy range from 0 to 15 MeV up to February 1970 are evaluated to derive the best available data, primarily for fast-reactor analysis. Limited comments are made on data published subsequently. Data are renormalized where necessary to the latest recommended value (3.756) for $\bar{\nu}_p$ for ^{252}Cf. Many of the existing lower-energy data for ^{233}U and ^{235}U indicate a nonlinear energy dependence that would be of significance for fast-reactor analysis; but a limited number of recent specific studies on ^{235}U strongly support linear dependence, and the existence of low-energy structure is not established. The more limited low-energy measurements on ^{239}Pu indicate little, if any, structure. At energies above several MeV the normally assumed linear energy dependence of $\bar{\nu}$ is more likely correct, but the occurrence of the (n,n′f) and (n,2nf) reactions in addition to the (n,f) reaction introduces a nonlinear dependence that is generally small but may be of significance for some isotopes. Consideration of the effects of first-, second-, and third-chance fission [(n,f), (n,n′f), and (n,2nf) reactions] gives a good fit to the single case, ^{235}U, in which a test can be made, and these effects are considered in the evaluation of other isotopes. (auth)

39056 SPIN-RELATED EFFECTS IN THE SCATTERING OF PROTONS AND IN (p,d) REACTIONS. Catillon, P. (CEN, Saclay, France). pp 313-29 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970). (In French).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

Experimental results (obtained chiefly with the Saclay cyclotron) on the interaction of polarized protons with about ten nuclides are presented and compared with available calculations. The measurements include elastic and inelastic cross-sections, depolarization, and asymmetry. It is concluded that spin-related parameters may now be measured with good precision and that they bring

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important information on the proton–nucleus interaction as well as on nuclear structure. (Canada)

39057 STUDY OF STRIPPING REACTIONS INDUCED BY 12 MeV VECTOR POLARIZED DEUTERONS. Roman, S. (Birmingham Univ., Eng.). pp 351-75 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

Recent work in Birmingham on polarization effects in stripping reactions, carried out with the 12.3-MeV vector-polarized deuteron beam of the Birmingham University Radial Ridge Cyclotron, is described. Experimental results for a range of target nuclei from ^{9}Be to ^{208}Pb are reported, some in a preliminary form. A comparison is made with predictions of DWBA calculations, considering j-dependent effects and showing that the additional information contained in polarization data ought to make the derivation of spectroscopic factors less ambiguous. The observed angular distribution of the vector analysing power for the reaction ^{208}Pb(d,p) ^{209}Pb at 1.57 MeV excitation suggests a Mott–Schwinger type of magnetic interaction, which may be dominant near the Coulomb Barrier. (auth)

39058 NUCLEAR REACTIONS AT MEDIUM ENERGY. Marty, N. (Institut de Physique Nucleaire, Orsay, France). pp 423-35 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970). (In French).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

A discussion of what can be learned from reactions at medium energies (particles of 100 to 200 MeV) is based mainly on the inelastic scattering and polarization of protons. Recent experiments on the elastic scattering of 167-MeV alpha particles and on (d,^{3}He) transfer reactions with 82-MeV deuterons are mentioned. (Canada)

39059 STRENGTH FUNCTION FOR THE s SHELL NEUTRONS AND LEVEL DENSITY PARAMETER OF STABLE NEODYMIUM ISOTOPES. Tellier, Henry (CEA, Saclay, France). Compt. Rend., Ser. B; 272: No. 11, 695-7(15 Mar 1971). (In French).

The total cross sections for stable neodymium isotopes were measured using the Saclay linear accelerator. The neutron energy was determined by time-of-flight measurements. Identification of the isotopes, and the analysis of the resonances enabled the strength function of the s neutrons to be determined for each isotope. The level density parameter a was also determined for the corresponding compound nuclei. (auth) (France)

Nuclear Theory

Refer also to abstracts 38625, 38723, 38867, 39018, 39019, 39029, and 39334.

39060 (INP–729) THEORY OF MAGNETIC DIPOLE MOMENTS OF SPHERICAL AND TRANSITION NUCLEI. Ogaza, Stanislaw (Institute of Nuclear Physics, Krakow (Poland)). Nov 1970. 13p. Dep. NTIS (U. S. Sales Only).

In the last few years various attempts were made in order to describe the magnetic properties of nuclei, on which the experimental data are increasing in number and accuracy. Although the electromagnetic interaction has a simple and well-known structure, thus providing a sensitive test of nuclear wave functions, no theory is capable yet to predict magnetic moments with a better accuracy than a few tenths of the nuclear magneton. The uncertainty in the theoretical estimates of magnetic moments arises from three main unsolved problems: the nucleonic interactions which modify somewhat the intrinsic structure of nucleons in nuclei and also the structure of the magnetic dipole operator; the distortion of the whole nucleus due to forces exerted by the "valence" nucleons on the core; and the complexity of the nuclear wave function for nuclei with more than one valence particle or hole. Various attempts, of phenomenological or semi-microscopic character, have met with moderate success in explaining the magnetic moments. Magnetic moment calculations with "realistic" forces are still at their beginning. Developments in all the three problems are discussed. (auth)

39061 (INR-P–1254) PENETRATION OF A DOUBLE POTENTIAL BARRIER IN FISSIONING NUCLEI. Dudek, J. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 10p. Dep. NTIS (U. S. Sales Only).

The transmission coefficient is calculated for double humped potential V(x) which has finite limits for |x| up to infinity. The potential is taken with the form of two inverted squared hyperbolic cosines joined together. (auth)

39062 (INR-P–1257) EFFECTIVE FORCE FOR THE NILSSON MODEL CALCULATIONS OF THE COLLECTIVE NUCLEAR PHENOMENA. Bochnacki, Z.; Gabrakov, S.; Zielinska-Pfabe, M. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 13p. Dep. NTIS (U. S. Sales Only).

A theoretical estimate of the strength and deformation dependence of the two-body interaction producing the nuclear field is discussed and tested by a RPA calculation. The conclusion is that the obtained two-body interaction may be used to describe the nuclear collective phenomena. (auth)

39063 (ITF–71–6–P) VARIATIONAL CALCULATION FOR A BOUND OF THE REGION OF EXISTENCE OF ATOMIC NUCLEI. Steshenko, A. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The bounds of the region of existence of atomic nuclei are calculated by a variational method. The exchange central NN-potential used in calculations is chosen to satisfy the two-particle experiments at low energies and to provide the saturation condition. The obtained results agree with the known experimental data; they are also consistent with the calculations of other authors. (auth)

39064 (JAERI–1205, pp 1-11) REVIEW OF PHOTONUCLEAR REACTIONS. Shoda, Katsufusa (Tohoku Univ., Sendai (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

A review on photonuclear reactions is made to discuss the current problems in this field. The general aspects of photonuclear cross sections are covered. The effects of isospin in photonuclear reactions are reviewed. Recent development of the theoretical treatment with the shell model is discussed. Special photoexcitation modes in both lower and higher energy regions of the giant resonance are discussed, especially on the direct emission of high energy protons, on the pigmy resonance and on the isobaric analogue states. Interference effects in photonuclear reactions are shown. An interesting example of the photoreaction study in connection with another field is presented (connection between E1 Isobaric Analogue State and β^{-}-matrix element). (auth)

39065 (JAERI–1205, pp 52-8) REVIEW ON THE PHOTONUCLEAR FISSION NEAR THE NUCLEAR FISSION THRESHOLD. Takekoshi, Eiko (Japan Atomic Energy Research Inst., Tokyo). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

A note is presented on the photonuclear fission near the nuclear fission threshold, in reference to the nuclear fission barrier observed in the photonuclear reaction, the photon absorption mechanism near the nuclear fission threshold, the relationships between excitation functions for the symmetric and the asymmetric fission modes and the photon absorption mechanisms, and analyses for the photonuclear fissions near the nuclear fission thresholds by using "double humped barrier". (auth)

39066 (JAERI–1205, pp 81-5) α-LIKE SPATIAL FOUR-BODY CORRELATIONS AND ELECTRON SCATTERING. Kamimura, Masayasu (Kyushu Univ., Fukuoka (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

α-like spatial correlations in closed-shell-core plus four-particle system are studied with use of the N.T.D. theory proposed by Marumori and Suzuki to treat four-body correlations in light nuclei. The theory formulated in angular momentum representation is developed in coordinate representation so as to involve the spatial correlations, namely α-like localization, in the four-body scattering eigenmode. A new orthogonal base is used in expanding the N.T.D. wave functions of four particles. Any member of the base is composed of all single particle wave functions of the usual shell model (in this sense the base is called a vertical truncation base), which guarantees the localization of four particles yielding

an α-cluster. The Pauli principle between the outer four particles and the core nucleus plays an important role and is well treated in the framework of Marumori and Suzuki. (auth)

39067 (JAERI-1205, pp 91-5) SIGNIFICANCE OF NUCLEAR PHOTOREACTION AMONG STUDIES IN THE CONTINUUM REGION. Fujii, Saburo (Nihon Univ., Tokyo). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

A new approach to nuclear excitations was found out in connection with the isospin selection rule on E1 transitions in self-conjugate nuclei. A strong excitation from 0^+, T = 0 to 1^-, T = 0 states due to electron inelastic scattering is characterized as a compressible mode. The microscopic description of this mode is attempted with a schematic model where the separable potential used is $G\, r_1^3\, r_2^3 \sum_m (-)^m Y_{1m}(r_1)\, Y_{1-m}(r_2)$. Several comments are made on some particle-hole studies of the giant resonance. The giant resonance energy is not yet completely understood on the basis of effective interactions derived from the realistic two-body forces. As regards the shape of giant resonance, various approaches to the continuum problem have been proposed to reproduce a characteristic of the coherent mode in the continuous energy region. The 1p-1h state should be considered to couple to many particle-many hole states. An effect of neutron-proton pairs in a nucleus is pointed out in connection with the analog states observed in (p,γ_0) and (e,e'p). In ^{90}Y, the mixing of $(1d_{5/2})_n\,(1p_{1/2})_p$ with $(0h_{11/2})_n\,(0g_{9/2})_p$ has a remarkable effect on the center of mass motion of the neutron-proton pair in both singlet and triplet states. The careful examination on this effect may solve a mystery indicated by Tanner et al. (auth)

39068 (JAERI-1205, pp 100-2) PHOTONUCLEAR REACTION AND DOORWAY STATE. Terasawa, Tokuo (Tokyo Univ. (Japan)). (In Japanese).

From Conference on the nuclear physics with electron linear accelerators; Tokyo, Japan (19 Feb 1970).

In Study of nuclear physics with linac.

A rough estimate was made on the ratio of the spreading widths of the electric dipole states with isospin T_0 and $T_0 + 1$, where T_0 is the isospin of the ground state. The estimate suggests that intermediate resonances with relatively small widths may be observed in the dipole spectrum with isospin $T_0 + 1$. It is also mentioned that this kind of intermediate structure might be seen in the proton energy spectra for (n,p) reactions, where the parents of the dipole states with $T_0 + 1$ can be formed as the final states. (auth)

39069 (JINR-E4-5767) POTENTIAL WELL DEPTH IN THE TWO-CENTER MODEL FOR HEAVY ION SCATTERING. Toepffer, Christian (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 8p. Dep. NTIS (U. S. Sales Only).

It is shown that the two-center shell model for fast collisions between nuclei gives correct values for the compression energy, if the variation of the depth of the potential wells with the compression of nuclear matter is taken into account properly. (auth)

39070 (JINR-P4-5678) DESCRIPTION OF THE REACTIONS OF GENERAL TYPE AND THE SHELL MODEL. Zakhar'ev, B. N.; Fenin, Yu. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

A method for description of reactions is suggested, in which a proper formulation of scattering-problem boundary conditions is combined with the expansion of wave functions of the whole system in the set of basis functions usually exploited in the ordinary shell model (bound states of nuclei). This allows one to use very similar calculation techniques for the problems of discrete and continuous spectra. (auth)

39071 (UCRL-Trans-1444) MANY-PARTICLE ISOMERIC NUCLEAR STATES AS SOURCES OF PROTON AND NEUTRON RADIOACTIVITY. Peker, L. K.; Volmyanskii, E. I. Translated for Univ. of California, Lawrence Radiation Lab., Berkeley, from a Russian preprint. 7p. Dep. NTIS.

Proton radioactivity of nuclei is difficult to observe because the region of proton-active nuclei is far from the band of beta stability. Proton radioactivity can be observed more easily in the excited isomeric states of nuclei, which are more nearly beta stable. Of particular advantage are many-particle isomeric states with high spin. Candidates for possible nucleon radioactivity are tabulated in the neutron-deficient and neutron-rich regions. (R.W.R.)

39072 ISOBARIC ANALOG RESONANCES IN PHENOMENOLOGICAL NUCLEAR SPECTROSCOPY. Ricci, R. A. (Istituto Nazionale di Fisica Nucleare, Padua. Univ., Padua). pp 218-36 of Evolution of Particle Physics. /Conversi, M. (ed.). New York; Academic Press Inc. (1970).

A comprehensive outline of the isobaric analog resonance phenomena is given. The importance of the isobaric analog resonances in offering clues for the correct interpretation of the observed structures in nuclear excitation spectra is pointed out. Some experimental data on isobaric analog resonances is reviewed. (J.W.R.)

39073 SIMPLE MODEL FOR THE CONTINUUM-CONTINUUM INTERACTION. Perez, J. D. (Univ. of California, San Diego, La Jolla); Stephenson, G. J. Jr. Contracts AT(11-1)-GEN-10; AT(40-1)-3765. Nucl. Phys.; A165: 152-60(1971).

An approximate method for calculating the effects of the continuum-continuum interaction, which arises in shell-model reaction theories, is presented and applied to the dipole photoabsorption cross section of ^{16}O in the Tamm-Dancoff approximation. The approximation consists of fitting analytic functions to selected bound-continuum matrix elements and utilizing these functions to calculate continuum-continuum and the remaining bound-continuum matrix elements. (Comparisons with selected exact calculations indicate at worst 20% error.) An upward shift in the position of the giant dipole resonance peaks and a decrease in the widths are found; the result is a 40% overall diminution in the total integrated cross section. (auth)

39074 KNOCK-OUT MECHANISM IN THE S-MATRIX THEORY OF DIRECT NUCLEAR REACTIONS. Danielopoulos, Stylianos Daniel. Raleigh, N. C.; North Carolina State Univ. (1970). 214p. University Microfilms Order No. 71-10,324.

Thesis.

The amplitude of direct nuclear reactions is obtained from unitarity and analyticity of the S matrix. Non-relativistic Feynman-diagram techniques are employed for the study of the singularities. Pole diagrams and triangle diagrams, in particular, are investigated. The knock-out mechanism is identified among the terms contributing to the unitarity expansion. Terms corresponding to triangle, as well as square diagrams, are shown to contribute to knock-out. Explicit expressions for the knock-out amplitude, for both spinless and spin-½ interacting particles, are obtained from the Feynman integral, corresponding to the triangle diagram. Some degree of separation of the integration variables is achieved in the heavy-core approximation. Expressions, suitable for numerical calculations, are also given. The complete reaction amplitude, which includes interactions in the initial and final states, is obtained as a solution of the Omnès-Muskhelishvili equation. The vertex functions are examined in detail, and some explicit expressions, for the case of a potential theory approach, are derived. The relationship between the S-matrix-theory approach and the distorted-waves-theory approach is examined. It is shown that the distorted-waves amplitude can be obtained as a lower-order approximation of the Feynman-diagram amplitude. Preliminary calculations for the reaction $^{13}C(p,n)^{13}N$ are carried out, and some qualitative results are given. (Diss. Abstr. Int., B)

39075 ANGULAR-MOMENTUM MATCHING IN THE STRONG-ABSORPTION MODEL. Frahn, W. E. (Univ. of Cape Town). Lett. Nuovo Cim.; 1: 561-4(27 Mar 1971).

A simple formulation of angular-momentum matching in l space, valid in any approximation in which the phase shifts are linear functionals of the potential, is considered. The basic result is $|\eta_l| \approx |\eta_l^0|^{f(l)}$, where η_l^0 and η_l are the scattering coefficients of the l-independent and l-dependent potentials, respectively, and f(l) is the cutoff function. Thus, the absorption cutoff affects only the modulus of η_l^0, by raising it to the power f(l), and leaves all real phase shifts unchanged. Several advantages of this simple formulation over that of the optical-model expression are given. (R.W.R.)

39076 EFFECTS OF THE N^*_{33} ISOBAR IN LOW ENERGY NUCLEAR PHYSICS. Green, A. M. (Laboratorium fuer Kernphysik, Zurich). Phys. Lett.; 34B: 451-4(29 Mar 1971).

It is shown that the large amount of attraction attributed to the σ meson in nuclear matter implies that the N^*_{33} isobars are as important as nucleons in highly excited intermediate states. Additional large contributions to the binding energy of nuclear matter and to magnetic moments result. (auth)

39077 ISOMORPHIC MODEL OF THE CLOSED-SHELL NUCLEI. Anagnostatos, Gerassimos Spiridon. Raleigh, N. C.; North Carolina State Univ. (1969). 185p. University Microfilms Order No. 71-10,246.

Thesis.

A microscopic model of nuclear structure of closed-shell nuclei (i.e., ^4He, ^{16}O, ^{40}Ca, ^{58}Ni, ^{90}Zr, ^{112}Sn, ^{142}Nd, ^{208}Pb, and ^{238}U) in the ground state, which is based on the least energy principle, is in-

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troduced. An isomorphism is established between the sets of quantum numbers (n, l, m, s, τ) characterizing the nucleons in a closed-shell nucleus and the points of a maximum spatial symmetry point-space. The point-space consists of the vertices of regular and quasi-regular polyhedra uniquely superposed under strict rules. The nucleons of the closed-shell nuclei in the ground state are assumed to have their expectation positions at the points of the isomorphic point-space. The model is characteristically simple and entirely new. It leads to simple explanations of the structures and various properties of the closed-shell nuclei and in all cases gives good agreement with measured values. For example, the neutron magic numbers, N = 2, 8, 20, 50, 82, and 126, are obtained simply and straightforwardly in this model whenever a neutron polyhedron obeying the rules of the isomorphic point-space is completed; thus, a possible structural interpretation of magic numbers arises. Nuclear properties successfully investigated on the basis of the proposed structure include nuclear shells and magic numbers, neutron excess, constant average density of nuclear matter, nuclear radii, moments of inertia, nuclear moments, nuclear surface, and nuclear interior. In addition, a formula for nucleon binding energies, containing only predetermined parameters based on the properties of the isomorphic point-space and nucleon state, is introduced and used successfully to find the nucleon and total binding energies of the closed-shell nuclei. With the nucleon binding energies obtained by this formula as a basis, a successful examination is also made of the possible origin and range of nuclear deformation, collective rotational excitation, termination of the periodic system of the elements, and possible supernuclei. (Diss. Abstr. Int., B)

39078 BOOTSTRAP THEORY OF VIBRATIONS IN NUCLEI. Nalcioglu, Orhan. Eugene, Oreg.; Univ. of Oregon (1970). 141p. University Microfilms Order No. 71-10,766.

Thesis.

A bootstrap theory of vibrations, which treats even- and odd-mass nuclei simultaneously and self-consistently, is formulated. The method proceeds from a consideration of the equation of motion of particle (quasi-particle) creation and destruction operators. The first order perturbative solutions of bootstrap theory correspond to the Random Phase Approximation (RPA). The method is first developed for the closed-shell region by employing a multipole–multipole interaction in particle representation, and is called the Extended-Particle (Hole)-Phonon-Coupling (EPPC)-Bootstrap theory. It is shown how the EPPC-Bootstrap theory may account for the nearness in energy of normal and nonnormal parity states in odd-mass nuclei. The bootstrap theory may also be used in finding the hole-stripping probability from the closed-shell ground state to the nonnormal parity states and modification of particle spectroscopic factors. Numerical calculations are carried out for ^{39,40,41}Ca, using perturbative solutions of the bootstrap equations. The second application is made using quadrupole-quadrupole interaction for the heavy spherical region where the quasi-particle representation is a better one. The formulation in this region is called the Extended-Quasi-particle-Phonon-Coupling (EQPC)-Bootstrap theory. An exact calculation is performed for ^{110}Pd. A finite value for the static quadrupole moment of 2+ state is found, having the correct sign and order of magnitude. The energy of the $g_{\frac{9}{2}}$ quasi-particle level is studied in the region where the $g_{\frac{9}{2}}$ level is being filled either by neutrons or protons (Se and Ag regions). The energy level systematics of quasi-particle–phonon-coupled levels based on $g_{\frac{9}{2}}$ quasi-particles is examined in Se and Ag regions. The bootstrap theory of pairing vibrations is next formulated for the pairing interaction. It is demonstrated that, at the extreme anharmonic limit, (when only the ground states of nuclei that differ by two particles are coupled) the bootstrap theory of pairing vibrations corresponds to BCS theory of superconductivity for nuclei. An alternative and simpler method is offered for nuclei near closed-shells, the Modified Tamm–Dancoff Approximation (MTDA), which takes into account the difference of single-particle distribution from shell-model values near closed shells. The numerical calculations are carried out for ^{58,60,62}Ni using MTDA. It is found that this simple approach (MTDA) gives an excellent description for ^{58,60}Ni (i.e., up to two-phonon states). It is also demonstrated how the bootstrap theory can give rise to quasi-rotational spectra in the transition region. (Diss. Abstr. Int., B) (TSS)

39079 PERTURBED ANGULAR CORRELATIONS: PERTURBATION FACTOR FOR ARBITRARY CORRELATION TIME. Blume, M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys.; A167: 81-6(1971).

An expression is derived relating the angular correlations as affected by time-dependent perturbations to those resulting from static interactions. The derivation is based on a model of Scherer [Nucl. Phys., A157: 81(1970)], and an error in his theory is corrected. The result is valid for all correlation times, and is convenient for numerical evaluation. The limits of applicability of the theory, which is based on a random-phase approximation and which is a special case of a more elaborate theory recently presented [Clauser and Blume, Phys. Rev., B3: 583(1971)], are considered. (auth)

39080 HFB CALCULATIONS WITH T = 1 AND T = 0 PAIRING CORRELATIONS. Wolter, H. H. (Univ., Muenster, Ger.); Faessler, Amand; Sauer, P. U. Nucl. Phys.; A167: 108-28(1971).

In HFB calculations the proton–neutron pairing with T = 0 and T = 1 should be included in addition to the normal pairing between like particles. The method for choosing the quasi-particle transformation to achieve this is considered, and calculations using reaction matrix elements based on a realistic nucleon–nucleon interaction are performed for some doubly even nuclei in the 2s–1d and 2p–1f shells. In N = Z nuclei T = 0 pairing is strong in excited HF states and may lead to a reordering or a near degeneracy of states of different deformation. In N ≠ Z nuclei T = 0 pairing is found only for a small neutron excess, when the HF gaps for both protons and neutrons are small. In these cases T = 0 and T = 1 pairings are about equally strong. (auth)

39081 DISPERSION EFFECT IN THE IWAMOTO–YAMADA CLUSTER EXPANSION. Wong, Chun Wa (Univ. of California, Los Angeles). Phys. Rev. Lett.; 26: 783-5(29 Mar 1971).

The use of auxiliary single-particle potentials permits the inclusion of the dispersion effect in the energy of a many-fermion system calculated in the independent-pair approximation of the Iwamoto–Yamada cluster expansion. (auth)

39082 SOME RANDOM-MATRIX LEVEL AND SPACING DISTRIBUTIONS FOR FIXED-PARTICLE-RANK INTERACTIONS. French, J. B. (Univ. of Rochester, N. Y.); Wong, S. S. M. Phys. Lett.; 35B: 5-7(26 Apr 1971).

Ensemble spectra are given for random matrices constrained to describe k-body interactions in f^7. The transition from semicircular to Gaussian, as k decreases, is demonstrated. The nearest neighbor spacing distributions agree well in all cases with the Wigner spacing law. (auth)

39083 SPIN–ISOSPIN SU(4) SYMMETRY IN THE (ds) SHELL. French, J. B.; Parikh, J. C. (Univ. of Rochester, N. Y.). Phys. Lett.; 35B: 1-4(26 Apr 1971).

A spectral distribution study shows that a conventional central interaction gives a fairly good SU(4) symmetry, in the ground-state energy domain, throughout the shell, but more realistic interactions give rise to large symmetry admixings. (auth)

39084 NUCLEAR ROTATIONAL BANDS AND SL(3,R) SYMMETRY. Weaver, Oliver Laurence. Durham, N. C.; Duke Univ. (1970). 97p. University Microfilms Order No. 71-10,433.

Thesis.

The idea that the group SL(3,R) may be an approximate symmetry group for rotational nuclei was studied. To this end several classes of unitary irreducible representations were found by solving the commutation relations and by using the method of induced representations. Matrix elements of the induced representations were used to predict reduced quadrupole transition rates and these predictions were compared with experimental data on even–even rare earth nuclei. The results of this comparison substantiate the usefulness of the group SL(3,R) in these nuclei. (Diss. Abstr. Int., B)

39085 OPTICAL MODEL POTENTIAL DEPTH FOR DEUTERONS. Kunz, P. D. (Niels Bohr Inst., Copenhagen). Phys. Lett.; 35B: 16-18(26 Apr 1971).

The first-order expression for the depth of the deuteron optical potential is derived from the non-local neutron and proton optical potentials. It is shown that the depth is evaluated by using the nucleon–nucleus depths at half the deuteron kinetic energy with a correction term due to the internal deuteron motion which reduces the depth by about 8%. (auth)

39086 EFIMOV'S EFFECT: A NEW PATHOLOGY OF THREE-PARTICLE SYSTEMS. Amado, R. D.; Noble, J. V. (Univ. of Pennsylvania, Philadelphia). Phys. Lett.; 35B: 25-7(26 Apr 1971).

It is proven rigorously that the number of bound states of a three-body system grows according to the formula $N \sim 1/\pi \ln(|a|/R)$ when the ratio of scattering lengths, a, to the range, R, of two-body forces is large, in agreement with Efimov's recent claim. The meaning of this effect is discussed in terms of the behavior of the Faddeev equations describing the three-particle system, and several points of Efimov's paper are clarified. (auth)

39087 CAN PHENOMENOLOGICAL PARTICLE–PARTICLE AND PARTICLE–HOLE FORCES BE DISTINGUISHED? Soeren-

sen, B. (Niels Bohr Inst., Copenhagen). Phys. Lett.; 35B: 8-10 (26 Apr 1971).

It is attempted to answer the question whether or not the simple, schematic forces widely used in nuclear structure calculations should be given particle–particle (hole–hole) character, particle–hole character or possibly a definite mixture. If the phenomenology of the forces is fixed by requiring a reproduction of experimental energy systematics then even a sensitive measure of the correlations as the two-nucleon transfer does not conclusively distinguish the mentioned types of interaction. The reaction $^{208}Pb(t,p)^{210}Pb$ is used as an example. (auth)

39088 *EFFECT OF THE DENSITY DEPENDENCE OF THE* FORCES ON FIRST-ORDER FINITE NUCLEAR CALCULATIONS. Nemeth, J. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 30: No. 1, 39-50(1971).

Hartree–Fock calculations are made with density-dependent forces, and the effect of density dependence on the results is examined. The single-particle and total energies and the average radii of spherical nuclei are determined. The results are compared with other calculations. Good agreement is found between theoretical and experimental values. (auth)

39089 INDEPENDENT-PARTICLE MODEL AND JASTROW CORRELATION DESCRIPTIONS OF ELECTRON QUASI-ELASTIC SCATTERING. Ciofi Degli Atti, C. (Istituto Superiore di Sanita, Rome. Istituto Nazionale di Fisica Nucleare, Rome). Lett. Nuovo Cim.; 1: No. 14, 590-5(3 Apr 1971).

Quasi-elastic scattering of electrons at several hundred MeV is considered. The following conclusions are reached: the quasi-elastic cross section can be reproduced by using single-particle momentum distributions that give the correct rms radius provided that the nucleon–nucleus final-state interaction is considered (through the use of distorted waves); due to the integration over the momentum of the unobserved nucleon, the quasi-elastic cross section can equally well be reproduced by using single-particle momentum distributions that give completely different coincidence (e,e'p) cross sections and charge form factors; and the effect of Jastrow correlations (in the conditions of the examined experiment) reduces to an overall small reduction of the quasi-elastic cross section. (R.W.R.)

39090 π PRODUCTION IN NUCLEI. Beder, D. S. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 49: 1448-51(1 Jun 1971).

The usual expression used for π production in nuclei takes the form expected of a classical process occurring in an inhomogeneous gas with a specified momentum distribution. In fact, this is shown to be formally inconsistent with quantum mechanics. A consistent quantum mechanical treatment of this problem is therefore established and the cross section predictions of this formalism in appropriate limits are examined. At best, a clumsy justification of the classical picture can be achieved. (auth) (Canada)

39091 RECUEIL DE PROBLEMES DE PHYSIQUE NUCLEAIRE ET DE PHYSIQUE DES PARTICULES. (Collection of Problems in Nuclear Physics and Particle Physics). Cottereau, M.; Lefebvres, F. Maitrise de Physique. A La Meme Libraire. Paris; Masson et Cie (1971). 419p. 90 f.

The topics discussed are atomic masses, Rutherford scattering, nuclear form factors, mirror nuclei, electric quadrupole moment of nuclei, kinematics of nuclear relations at low frequency, relativistic kinematics, energy threshold for endoenergetic reactions, and the kinematics of nonrelativistic elastic scattering. The Compton effect, bremsstrahlung and materialization, passage of charged particles through matter, the proportional counter, detection of slow and thermal neutrons, the Cherenkov detector, xenon poisoning of nuclear reactions, and isobaric transitions are covered. Nuclear reactions at low energies, compound nuclei, nuclear shell model, the linear accelerator, the synchrotron, the proton synchrotron, the deuteron, and properties of a high-energy neutron beam from a deuteron beam are considered. Also included are properties of the $N + N \rightarrow d + \pi$ reaction, $n + p \rightarrow n + p$ scattering, scattering partial-wave analysis, total scattering and reaction cross sections, a scattering model, πp interactions, parity violation in the decay of A^0, and the puzzle of θ^+ and τ^+ mesons. (J.F.P.)

39092 SIMPLE THOMAS–FERMI MODEL FOR NUCLEI WITH DIFFERENT PROTON AND NEUTRON NUMBER. Nemeth, J. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 30: No. 1, 11-21(1971).

Through the use of realistic two-body potentials and the results of nuclear many-body calculations for infinite nuclei, a modified Thomas–Fermi theory is developed for nuclei with different proton and neutron numbers. Coupled nonlinear integral equations are deduced to determine the proton and neutron density distributions separately. The method is applied for a simplified case with rectangular density distribution. The ranges of the neutron and proton density distributions turn out to be equal. (auth)

39093 THEORETICAL SEARCH FOR A POSSIBLE REGION OF SUPERHEAVY ELEMENTS. Nilsson, Sven Goesta (Lund Inst. of Tech., Sweden). pp 43-80 of Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research. XIII. /Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970).

From Robert A. Welch Foundation conferences on chemical research. XIII. The transuranium elements; Houston, Tex. (17 Nov 1969). See CONF-691124.

Theoretical predictions for an island of nuclear stability beyond the present limits of the periodic table are discussed. Previous developments in nuclear models for predicting such an island or islands are briefly reviewed. The work of the Lund group on this subject is examined in more detail. (J.W.R.)

39094 NUCLEON SHELLS, THE STRUCTURAL STABILITY OF NUCLEI AND FISSION. Strutinskii, V. (Inst. of Atomic Energy, Moscow). pp 83-103 of Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research. XIII. /Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970).

From Robert A. Welch Foundation conferences on chemical research. XIII. The transuranium elements; Houston, Tex. (17 Nov 1969). See CONF-691124.

The role of shell structure in describing the shapes of heavy nuclei, in predicting the stability of superheavy nuclei, and in describing the fission process is examined. (J.W.R.)

39095 FISSION ISOMERS AND INTERMEDIATE STATES IN NEAR-BARRIER FISSION. Bjoernholm, Sven (Univ. of California, Berkeley). pp 447-81 of Proceedings of the Robert A. Welch Foundation Conferences on Chemical Research. XIII. /Milligan, W. O. (ed.). Houston, Tex.; Robert A. Welch Foundation (1970).

From Robert A. Welch Foundation conferences on chemical research. XIII. The transuranium elements; Houston, Tex. (17 Nov 1969). See CONF-691124.

The theoretical and experimental data on fission isomers and resonance fission is reviewed. The implications concerning the predictions for superheavy elements are examined. (J.W.R.)

39096 PARTIAL WIDTH CORRELATIONS AND COMMON DOORWAY STATES. Lane, A. M. (Atomic Energy Research Establishment, Harwell, Eng.). Ann. Phys. (N. Y.); 63: No. 1, 171-218(Mar 1971).

A theory for the various correlations discovered between different nuclear reaction data is developed. In particular, an attempt is made to understand the recently reported positive correlation of neutron and partial photon widths of neutron resonances. The older data on the positive correlation of (d,p) and (n,γ) cross sections is also considered. A compact formalism for discussing correlations is given, and it is shown that they are closely related to the existence of "direct" cross sections. One can see that strong correlations are associated with the existence of isolated doorway states, as suggested by Chrien and Bartholomew and co-workers; further, such doorway states must be "common" to both channels. A discussion is given in terms of current models on whether or not such common doorways are expected to occur in practice. A detailed calculation of the 1^- states of ^{208}Pb and ^{60}Ni shows how such states can occur. In ^{208}Pb, they are three states having large components of the $3p^{-1}\,4s$ configuration, which is associated with most of the neutron and photon strength in the vicinity of 6 MeV. A by-product of this study is an explanation of the "pygmy" dipole resonance. In the course of developing the theory, the relevant experimental data on correlations is presented and discussed. (auth)

39097 EFFECTS OF THE PARTICLE NUMBER NONCONSERVATION ON THE ONE-NUCLEON TRANSFER REACTIONS IN SPHERICAL SUPERCONDUCTOR NUCLEI. Bonsignori, G. (Univ., Bologna); Savoia, M. Nuovo Cim.; 3A: No. 2, 309-22 (21 May 1971).

The spectroscopic factors of one-nucleon transfer reactions for nuclei, usually treated with the superconductivity techniques, are calculated in a simple model conserving the particle number operator. States of even nuclei are approximated by superpositions of components of zero– and two–quasi-particle excitations, corresponding to the correct number of particles. Analogously states of odd nuclei are taken to be components of one–quasi-particle states with a fixed number of particles. Numerical values are

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obtained for stripping and pick-up reactions on even and odd tin isotopes. They are compared with the results of the corresponding quasi-particle theory and with the experimental data. (auth)

39098 TREATMENT OF A NILSSON POTENTIAL IN THE BASIS OF ASYMPTOTIC QUANTUM NUMBERS. Boisson, J. P.; Piepenbring, R. (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Phys.; A168: No. 2, 385-98(1971).

The energy levels and wave functions of Lamm's version of the Nilsson potential are computed using a basis of asymptotic quantum numbers. Applications to the evaluation of decoupling factors, magnetic moments, and low-multipole electromagnetic transitions are given. In comparing with the original treatment of Nilsson, correction terms depending on the deformation are introduced. The M1 transitions with $\Delta\Omega = 0$ are not affected by these correction terms. In E1 transitions and E2 transitions with $\Delta\Omega \neq 0$, a correction factor of the first order is introduced. In the evaluation of decoupling factors, magnetic moments and M1 transitions with $\Delta\Omega = \pm 1$, a second-order correction appears. As predicted by Nilsson, estimates of the matrix elements of the quadrupole moment and E2 transitions with $\Delta\Omega = 0$ may in some cases be very drastically affected. (auth)

39099 DENSITY-DEPENDENT LOCAL EFFECTIVE INTERACTION BETWEEN NUCLEONS IN NUCLEAR MATTER. Sprung, D. W. L. (Institut de Physique Nucleaire, Orsay, France); Banerjee, P. K. Nucl. Phys.; A168: No. 2, 273-306(1971).

A local effective interaction, that reproduces the G-matrix elements from an infinite nuclear matter calculation using the Reid potential, is constructed. The interaction is defined to reproduce diagonal G-matrix elements. It is expressed as a sum of Gaussians, and the density dependence and starting energy dependence are parameterized in simple ways. Following Negele, averages over angular momentum reduce the force to an effective central interaction. Renormalization factors affecting the short-range part of the interaction are supplied which allow one to use a force having a specified binding energy and saturation density, and within limits to adjust the symmetry energy and compressibility of nuclear matter. The force is suitable for finite nucleus Hartree–Fock studies in the local density approximation, where the sensitivity to the above listed properties can be studied systematically. Some problems connected with the rearrangement symmetry energy are discussed. (auth)

39100 EFFECTS OF PARITY VIOLATION IN INELASTIC SCATTERING REACTIONS WITH PHOTON EMISSIONS. Lobov, G. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 34: 1141-4(1970). (In Russian).

Studies were made of the ρ-odd effect in the circular polarization of photons emitted by nuclei excited during inelastic resonance particle scattering on non-polarized nuclei. (R.V.J.)

39101 EXCITED STATES OF DEFORMED ODD-PARITY NUCLEI WITH SMALL NONAXIALITY. Isakov, B.; Sharipov, Sh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 4, 65-9(1970). (In Russian).

A model of odd-parity nuclei with the excited states divided into single-particle and collective state was used for studying properties of deformed odd nuclei and the effects of deformation on excited states of slightly non-axial odd nuclei. Calculations were made assuming that the γ oscillations on the surface of the odd nucleus were small ($\gamma_0 \approx 0$) in relation to the equilibrate magnitudes, that excitation changed the shape of the nucleus, and introducing the parameter $\rho_{eff} = (\beta_{eff}/\beta_0) \geq 1$, which efficiently took into account the changes in β deformation parameter. The results showed that a separate band with a spin sequence, identical to the ordinary band predicted by adiabatic theory, appeared with large magnitudes of the ρ_{eff} parameter of the spectra of deformed odd–odd nuclei. Theoretical data were correlated with the tabulated experimental data for ^{225}Ac and ^{131}Xe nuclei. (R.V.J.)

39102 COMPUTERS AND THE OPTICAL MODEL FOR NUCLEAR SCATTERING. Tamura, T.; Coker, W. R. (Univ. of Texas, Austin). pp 405-35 of Computers and Their Role in the Physical Sciences. /Fernbach, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

The use of computers in applying the optical model to nuclear scattering is discussed. The basic ideas of nuclear scattering are reviewed, and the aims and nature of the optical model are explained. (J.W.R.)

39103 RECOIL NUCLEI ASYMMETRY IN THE CAPTURE OF μ MESONS BY THE ^{11}B NUCLEUS. Bukhvostov, A. P.; Vartanyan, V. A.; Ozievich, Z.; Popov, N. P.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 4, 820-4(Apr 1971). (In Russian).

The angular distribution of the recoil nuclei is calculated relative to the polarization vector of μ mesons in reaction $\mu^- + {}^{11}B \rightarrow {}^{11*}Be(1/2^-) + \nu$. The asymmetry coefficient is analyzed as a function of weak interaction constants, polarization parameters of mesoatom and nuclear matrix elements. The time dependence of the recoil nuclei asymmetry is analyzed. The asymmetry coefficient was found to be weakly dependent on the model parameters and g_P, g_T. The calculations show that the asymmetry coefficient is positive-definite in a wide range of possible values of the parameters calculated within the (V–A) theory. (auth)

39104 RELATION BETWEEN CLASSICAL AND QUANTUM MECHANICAL RIGID MOTION. Bertsch, George F. (Princeton Univ., N. J.). Ann. Phys. (N. Y.); 63: No. 2, 534-40(Apr 1971).

Conditions are given on a quantum-mechanical system that effectively reduce the Hamiltonian to a rigid-body Hamiltonian derived with classical mechanics. (auth)

39105 COLLECTIVE ENERGIES FROM MOMENTUM- AND ANGULAR MOMENTUM-PROJECTED DETERMINANTAL WAVE-FUNCTIONS. Villars, Felix; Schmeing-Rogerson, Nancy (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Ann. Phys. (N. Y.); 63: No. 2, 443-58(Apr 1971).

Determinantal many-particle wave functions, as used in Hartree–Fock theory of finite nuclei, are not eigenfunctions of the total linear momentum or, generally, of the total angular momentum. A simple derivation is given for the expression for the energy in terms of momentum- or angular momentum-projected determinants. A variational principle based on this expression is used to determine the collective energy (center-of-mass kinetic and rotational energy). This method gives the correct energy of center-of-mass motion and, in the case of strong deformation, the Thouless–Valatin self-consistent cranking result for the rotational energy. (auth)

39106 ASYMPTOTIC EVALUATION OF THE GREEN'S FUNCTION FOR LARGE QUANTUM NUMBERS. Balian, R.; Bloch, C. (CEN, Saclay, France). Ann. Phys. (N. Y.); 63: No. 2, 592-606(Apr 1971).

In an attempt to extend the shell model to highly deformed states of heavy nuclei, the evaluation of the Green's function for the Schroedinger equation in three dimensions with a smooth potential is discussed in the limit of large quantum numbers. Such an evaluation is possible only after smoothing over the energy, and this process results in the introduction of complex energies. The zeroth order (semiclassical) approximation requires the resolution of the Hamilton–Jacobi equation for complex energies. For a sufficiently large smoothing width, the Green's function is expressed as a local expansion based on the Taylor-series expansion of the potential. Higher-order corrections to the semiclassical approximation are derived from an integral equation for the Green's function. These corrections produce, in particular, the reflected waves from the caustic (which generalizes the turning points in three dimensions). The connection with the usual WKB method is discussed in the one-dimensional case by considering the limit of a small smoothing width. The quantum corrections to the Thomas–Fermi model are derived as a first application of these methods. (auth)

39107 MODEL OF THE RANDOM FUNCTION ASSOCIATED WITH POISSON-TYPE DECAY PHENOMENA. Arques, Pierre-Yves (Rennes Univ., France). J. Phys. (Paris); 32: 1-5(Jan 1971). (In French).

A statistical model is studied which can be applied to radioactive decay phenomena involving several successive emissions. Each event produces a random pulse. The two first-order statistical averages of the resultant random function are derived; they depend on the various laws of random delays associated with the decay phenomena. (auth) (France)

39108 AXIAL VECTOR NUCLEAR SUM RULES AND EXCHANGE EFFECTS. Ericson, Magda (Institut de Physique Nucleaire, Lyon, CERN, Geneva). Ann. Phys. (N. Y.); 63: No. 2, 562-76(Apr 1971).

The nuclear pionic vertex and its relation to the π–nucleus (charge-exchange) scattering length are investigated using dispersion techniques. The aim is to extract information on mesonic (exchange-current) effects in the pionic vertex and in the axial-vector-current matrix element. A sum rule is obtained: The sum of pionic vertices between the ground state and all excited nuclear states is connected to an integral of the total π–nucleus cross section in the (3,3) resonance energy and above. The exchange-current effects are shown to be related in a model-independent way to shadow phenomena in the cross section. The Goldberger–Treiman relation extends this result to Gamow–

Teller matrix elements (nuclear Adler–Weisberger sum rule). Estimates are given for the renormalization of the axial coupling constant in some nuclei. (auth)

39109 NONSTATIC SECOND ORDER CONTRIBUTION TO THE ELASTIC ELECTRON–NUCLEUS SCATTERING. Bethe, H. A. (Cornell Univ., Ithaca, N. Y.); Molinari, A. Ann. Phys. (N. Y.); 63: No. 2, 393-431(Apr 1971).

Three methods are used to estimate the nonstatic second-order corrections to elastic electron scattering by nuclei. In the first method, an imaginary potential is constructed to take into account "absorption" by inelastic scattering. In the other two methods, the second-order amplitude is directly evaluated—in method II by considering the giant resonance as the intermediate state and in method III by closure over all intermediate states. The third method is probably most reliable. All methods agree in giving very small corrections to the elastic scattering; in particular, diffraction minima are neither appreciably filled in nor shifted. (auth)

39110 FULLY CONSISTENT PHASE CONVENTIONS IN ANGULAR MOMENTUM THEORY. Danos, Michael (National Bureau of Standards, Washington, D. C.). Ann. Phys. (N. Y.); 63: No. 2, 319-34(Apr 1971).

By a slight modification of the phase conventions of angular-momentum algebra, all phases can be eliminated from the formulas; consequently, a simple, true, graphical representation of the complete Racah algebra can be constructed. In this way all topological questions of the recoupling transformations can be solved graphically, and one can write directly the algebraic expression of the final result. (auth)

39111 QUADRUPOLE MOMENT OF THE FIRST EXCITED STATE OF EVEN–EVEN SPHERICAL NUCLEI. Boldrighini, C. (Univ., Rome). Lett. Nuovo Cim.; 1: No. 21, 849-52(22 May 1971).

A model is proposed to relate the quadrupole moments of the first excited states of some spherical even–even nuclei to the low-lying spectra of neighboring even–odd nuclei. The treatment can be applied to nuclei with a single closed shell, if the effective charge is known; pure $j-j$ coupling is assumed. The theory is checked by using the nuclei ^{204}Pb and ^{205}Pb. Reasonable behavior of the level spreading as a function of the quadrupole Q is obtained. The quadrupole moment of ^{205}Pb is found to be about 0.5 b. (R.W.R.)

39112 DIRECT INTERACTION THEORY AND NON-HERMITICITY OF THE LAPLACIAN OPERATOR. Morsy, M. W.; Ata, M. S. (Atomic Energy Establishment, Cairo). Atomkernenergie; 17: No. 4, 271-3(Jul 1971).

In view of the fact that the Sturm–Liouville differential operator is not Hermitean, it is desirable to investigate the Hermiticity property of the Laplacian operator and its implications on the decomposition of the transition matrix element into direct-interaction and compound-nucleus parts. In fact, it is proved that the Laplacian operator is not Hermitean; as a consequence, two extra matrix elements are obtained in addition to the conventional direct-interaction and compound-nucleus ones. (auth)

39113 COUPLED-CHANNEL FORMULATION FOR HIGH-ENERGY INELASTIC NUCLEAR SCATTERING. Kujawski, E. (Univ. of Maryland, College Park). Lett. Nuovo Cim.; 1: No. 18, 734-8(1 May 1971).

High-energy inelastic nuclear scattering is investigated in terms of an equivalent infinite system of coupled equations, up to second order in the inelasticity, including all contributions, with elastic scatterings in the intermediate states. It is found that the multiple-scattering contributions may be important and, therefore, formulations based on the impulse approximation or the distorted-wave impulse approximation are likely to be invalid. It is proposed that high-energy inelastic scattering be investigated by using coupled-channel equations, the form of which is determined by the structure of the target nucleus. (R.W.R.)

39114 EXCITATION MECHANISMS OF THE NUCLEUS. ELECTROMAGNETIC AND WEAK INTERACTIONS. Eisenberg, Judah M.; Greiner, Walter. Nuclear Theory. Volume 2. New York; American Elsevier Publishing Company, Inc. (1970). 380p. $19.25.

A theoretical description of various mechanisms for probing nuclear structure is presented; because they are better understood, electromagnetic and weak interactions of nuclei are emphasized. The topics covered include photon reactions in nuclei (particularly the photonuclear giant resonance), elastic and inelastic electron scattering, Coulomb excitation, muonic atoms, beta decay, and muon capture. Background material on multipole fields and the quantization of the electromagnetic field is included. (R.W.R.)

39115 NUCLEAR MODELS. COLLECTIVE AND SINGLE-PARTICLE PHENOMENA. Eisenberg, Judah M.; Greiner, Walter. Nuclear Theory. Volume 1. New York; American Elsevier Publishing Company, Inc. (1970). 488p. $19.25.

The concept of collective coordinates and the construction of the collective nuclear Hamiltonian are first developed, and then the collective potential-energy surface is discussed. The quantum mechanics of the rotator is presented as preparation for the detailed treatment of the rotation–vibration model and the asymmetric-rotator model. The relation between these models is explored at some length. The spherical and deformed shell models and the unified model are introduced to allow treatment of the interaction of single-particle and collective degrees of freedom. The subject of phenomenological collective descriptions is resumed in the presentation of nuclear hydrodynamics as the basis of a discussion of the dynamic collective model for deformed and spherical nuclei. Finally, nuclear models are applied to heavy-ion scattering. The emphasis is the physical picture behind the various models; at the same time, a complete mathematical description is presented. (R.W.R.)

39116 CALCULATING (n,2n) REACTION AMPLITUDES OF HEAVY NUCLEI. Olkhovskii, V. S. (Kiev State Univ.); Recami, E.; Ezhov, S. N. Lett. Nuovo Cim.; 1: No. 19, 787-92(8 May 1971).

(n,2n) knock-out reactions with very heavy nuclei are considered; a method for evaluating these amplitudes and investigation of some of their properties is suggested. It is shown that the system can be approximated by a finite-number equation system with a unique approximate solution to any degree of accuracy. Only a few main terms in the expansions of the inhomogeneous parts of the algebraic equations must be considered. The method is extendible to the many-particle case. Rescattering contributions to (n,2n) reactions are considered from the point of view of final-state interactions. Rescatterings of this type produce kinematical peaks in the total cross section as a function of the laboratory kinetic energy in the energy range of a few tenths of a MeV to a few MeV. (R.W.R.)

39117 RESCATTERING CORRECTIONS TO THE ABSORPTION OF FREE PIONS IN COMPLEX NUCLEI. Kaushal, R. S. (Indian Inst. of Tech., Kanpur). Lett. Nuovo Cim.; 1: No. 19, 793-6(8 May 1971).

The effects of rescattering on the process of single-nucleon emission $_Z^AX(\pi^+,p)_{Z-1}^{A-1}X$ following π^+ absorption are studied in perturbation theory. Plane waves are used in the impulse approximation, and only corrections from coherent rescattering (in which the nucleus remains in the ground state during the rescattering process) are included. Numerical calculations are done for the reaction $^{12}C(\pi^+,p)^{11}C$ at 68 MeV; in particular, the absorption is considered to be by a $0s_{\frac{1}{2}}$ neutron. Depending on the normalization used, the net contribution of the rescattering is found to be 72 or 250%; these large values are attributed to higher-order effects. (R.W.R.)

39118 ONE-PARTICLE NUCLEAR-DENSITY MATRIX. Boffi, S. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Lett. Nuovo Cim.; 1: No. 22, 931-3 (29 May 1971).

A phenomenological approach is considered for the investigation of the ground-state (gs) properties of nuclei in the Hartree–Fock approximation by means of the one-particle nuclear-density matrix. It is concluded that even a finite linear combination of Slater determinants is inadequate to describe the gs properties of a nucleus as light as ^{4}He. This would mean that the phenomenologically obtained one-particle density matrix is not pure N-representable; i.e., it does not correspond to an antisymmetric gs wave function that is a pure state of the Hilbert space of N-particle functions. (R.W.R.)

39119 ROTATIONAL LEVELS IN A SIMPLE SHELL-MODEL CONFIGURATION. Tanaka, Yasutoshi; Ogawa, Kengo; Arima, Akito (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 1, 85-103(Jan 1971).

Systems of ($j_1^{\frac{1}{2}}$(proton), $j_2^{\frac{1}{2}}$(neutron)) configurations are examined for the purpose of studying the role of neutron–proton correlation. Residual interactions of δ + QQ type are assumed. Protons and neutrons are strongly coupled by the attractive neutron–proton interaction (both short range and long range), which causes rotational features with the axial symmetry in two-proton and two-neutron systems. Because the coupling of protons with neutron holes is weak, however, this leads the two-proton and two-neutron

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hole system to show no rotational property with the axial symmetry. In the former system, the ground $K = 0^+$ band and also an excited $K = 1^+$ band appear, provided that j_1 and j_2 are large and the QQ interaction is strong. Exact wave functions of the ground band members and $K = 1^+$ band members are very similar to projected states from intrinsic wave functions given by the aligned coupling scheme. (auth)

39120 EXAMPLE OF APPLICATION OF PARASTATISTICS FOR NUCLEON PAIRS IN NUCLEAR SHELLS. Govorkov, A. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 7: No. 2, 230-40(May 1971). (In Russian).

It is shown that in the Cusson model, where the states of nucleon pairs in nuclei are considered on the basis of parastatistics, all states can be related to irreducible representations of parastatistics. By means of the Klein transformation the problem is reduced to the many-body problem with the usual Fermi statistics and "particles" possessing internal degrees of freedom and the "spin" spectrum 0, 2, 4,... (auth)

39121 RELATION BETWEEN THE TRANSLATIONALLY INVARIANT SHELL MODEL AND THE K-HARMONICS METHOD. Kurdyumov, I. V.; Smirnov, Yu. F.; Shitikova, K. V. (Moscow State Univ.). Teor. Mat. Fiz.; 7: 45-55(Apr 1971). (In Russian).

The relation between the translationally invariant shell model and the K-harmonics method is investigated. The analysis of this problem makes it possible to use the formalism developed in the translationally invariant shell model for the construction of K harmonics with arbitrary values of K. (auth)

39122 OCTUPOLE VIBRATIONS OF FISSIONING NUCLEI. Ohta, Kohichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 1, 70-84(Jan 1971).

The cluster model of heavy nuclei is developed for a unified description of both the low-lying negative-parity states and the fission process on the assumption of complete adiabaticity. A schematic model (state-independent pairing-plus-octupole model) is investigated within the framework of the RPA, and the close relation between octupole vibrational states and asymmetric fission is discussed. (auth)

39123 PROCEEDINGS OF THE SYMPOSIUM ON NUCLEAR REACTION MECHANISMS AND POLARIZATION PHENOMENA, HELD AT QUEBEC, CANADA, SEPTEMBER 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970). 506p. $15.00. (In French and English). (CONF-690976).

Separate abstracts were prepared for 15 of the papers that appear in this volume. (R.W.R.)

For abstracts of individual papers see: 38837, 38874–38876, 38916, 38917, 38957, 38958, 39056–39058, and 39124–39127.

39124 THEORY OF ANALOG RESONANCES. Fallieros, S. (Brown Univ., Providence). pp 3-18 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

The asymmetric energy distributions of the strength function and the transmission coefficients, and the conditions under which these quantities vanish at a certain point in the spectrum, are summarized. A brief outline of the theory of isobaric analog resonances is also given. (Canada)

39125 L–S COUPLING IN THE MACROSCOPIC AND MICROSCOPIC DESCRIPTIONS OF THE INELASTIC SCATTERING OF PROTONS. Raynal, J. (CEN, Saclay, France). pp 75-119 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970). (In French).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

The effect of a deformed $\vec{L} \cdot \vec{S}$ coupling on the partial-wave amplitudes in a macroscopic description of the scattering is related to the solution of a set of coupled differential equations. An iterative method of solution is used to obtain results for elastic and inelastic cross-sections and asymmetries for several target nuclei. Curves showing the convergence of the iterative solutions and the effects of different deformations are presented. The microscopic description for a system with a zero-range $\vec{L} \cdot \vec{S}$ interaction is used to derive a coupling very similar to the one used in the macroscopic theory. The microscopic description yields some understanding of why $\vec{L} \cdot \vec{S}$ coupling is more important for some nuclei than for others. (Canada)

39126 MACROSCOPIC TO MICROSCOPIC: RECENT WORK ON THE OPTICAL MODEL. Hodgson, P. E. (Nuclear Physics Lab., Oxford). pp 121-229 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

Macroscopic and microscopic analyses of nuclear reactions are beginning to link up, partly because more accurate data have reduced the ambiguities in the phenomenological analyses and partly because more tractable ways of carrying out the basic calculations from the nucleon–nucleon interactions have been developed. This theme is illustrated from recent work on (a) elastic scattering: with reference to refinements in the parameterisation of the optical potential, calculations of the optical potential from nucleon–nucleon interactions, determinations of nuclear charge and matter distributions, and discussions of resonance phenomena; (b) inelastic scattering: with discussions on collective and microscopic form factors; (c) nucleon transfer reactions; (d) isobaric analogue state reactions; and (e) total cross sections. (Canada)

39127 ANTISYMMETRIZED D.W.B.A. AND MICROSCOPIC WAVE-FUNCTIONS. Schaeffer, R. pp 231-65 of Proceedings of the Symposium on Nuclear Reaction Mechanisms and Polarization Phenomena, Held at Quebec, Canada, September 1–2, 1969. Quebec; Les Presses de l'Universite Laval (1970). (In French).

From Symposium on nuclear reaction mechanisms and polarization phenomena; Quebec, Canada (1 Sep 1969). See CONF-690976.

The antisymmetrisation of the incident proton wave-function in (p,p′) scattering and the exchange character of the nucleon–nucleon force are very important. Omission of these effects can give an error in the absolute cross-section of a factor in the range of two to ten, depending on the beam energy and the spin transfer. The antisymmetrized DWBA using a free low-energy nucleon–nucleon force and no adjustable parameters correctly predicts the experimental magnitudes of the cross sections for (p,p′) scattering on ^{40}Ca to the lowest 3^- and 5^- states over a range of energies (20 to 55 MeV), provided that good microscopic wave-functions are used to describe the particle–hole states. The detailed fit to the experimental angular distributions and polarisations may be improved if one uses a more complete nucleon–nucleon interaction containing spin–orbit and tensor terms. (Canada)

39128 CONCEPTS OF NUCLEAR PHYSICS. Cohen, Bernard L. McGraw-Hill Series in Fundamentals of Physics: An Undergraduate Textbook Program. New York; McGraw-Hill Book Company (1971). 445p. $14.95.

The introductory material includes a brief description of the basic properties of nuclei, a quantum mechanical treatment of a particle in a potential well, and a detailed discussion of the nuclear force. The shell model theory of nuclei is then introduced and nuclear structure and decay and reaction processes are treated in terms of the model. A chapter on applications of nuclear physics is also included. (J.W.R.)

39129 USEFUL RECURRENCE FORMULA FOR THE EQUATIONS OF RADIOACTIVE DECAY. Hamawi, John N. (Stone and Webster Engineering Corp., Boston). Nuc. Technol.; 11: No. 1, 84-8(May 1971).

Systems of linear differential equations of the type occurring in the theory of radioactive transformations are normally solved by direct integration. For certain complex systems the solutions may contain a formidable number of terms and would therefore be extremely laborious to derive. This paper presents a more practical method for solving such systems of equations. By means of a recurrence formula the method provides simple, compact, readily derivable expressions and considerably reduces the length of numerical computation. The method is well suited for use with digital computers. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 37537, 39154, 39221, and 39241.

39130 (A/CONF.49/P–62) STATUS OF THERMAL REACTOR FUEL MANUFACTURE IN THE UNITED STATES. Lotts, A. L.; Washburn, T. N. (Oak Ridge National Lab., Tenn.); Geller, L. (Stoller (S. M.) Corp., New York); Klepfer, H. H. (General Electric Co., Wilmington, N. C.); Layman, W. H. (Atomic Energy Commission, Washington, D. C.). Sep 1971. 16p. (CONF-710901–37). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Fuel-fabrication services are being offered in the U.S. for two classes of thermal reactors: the light-water reactor (LWR) and, less extensively, the high-temperature gas-cooled reactor (HTGR). From a fuel-fabrication requirement of approximately 1000 metric tons per year in 1970, the demand will approach 15,000 metric tons per year in 1990. Nine manufacturers are offering fuel-fabrication services for LWR's, and one firm is offering fuel for the HTGR. Although most commercial offerings are now for UO_2-fueled cores, the Pu stockpile from LWR's will stimulate the marketing of UO_2–PuO_2 fuel. Pu available for recycle will increase from a cumulative total of 2.5 metric tons in 1970 to 300 to 500 metric tons in 1990. The fuel-fabrication service normally offered includes nuclear and physical design of the fuel element and its warranty. All fuel designs in use for LWR's are based on mechanical assembly of fuel rods loaded with ceramic pellets. The principal manufacturing operations are converting UF_6 to UO_2, fabricating pellets, loading and sealing fuel rods, fabricating fuel rods into elements, and the accompanying inspection steps. The fuel element for the HTGR is a graphite block containing spherical particles coated with pyrolytic carbon and silicon carbide. In the absence of manufacturers' detailed practices and cost experience, estimates of cost trends have been made through the use of computer models of fabrication plants. The results correspond closely with quotations of the fuel manufacturers. Included in this study are the effects of such variables as plant scale, isotopes employed, fuel-element dimensions, specifications and quality-control requirements, and alternative process steps for all commercially important thermal reactor fuels. In addition, a summary of the effect of plant-expansion strategy on cost is described. 29 references. (auth)

39131 (A/CONF.49/P-103) TECHNICIANS, TECHNOLOGISTS, AND ENGINEERS FOR NUCLEAR POWER. Palladino, N. J. (Pennsylvania State Univ., University Park. Coll. of Engineering); Benedict, M. (Massachusetts Inst. of Tech., Cambridge); Kerr, W. (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering); Murray, R. L. (North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering). Sep 1971. 16p. (CONF-710901-44). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The need for technicians, technologists, and engineers in the nuclear-power industry has grown steadily in recent years and may be expected to accelerate. Education of these individuals has taken many forms. Early educational activities were centered in the national laboratories of the U.S.A.; then nuclear-engineering curricula were included in universities, and more recently specialized programs have been developed in industry. University programs continue to benefit from financial assistance from the USAEC. Additional needs exist for support of nonmission-oriented research for faculty and graduate students specifically interested in nuclear-engineering problems. Although early emphasis in nuclear-engineering education focused on graduate work, notable growth is taking place in baccalaureate and two-year engineering technology programs at universities because of growing demands from utilities using nuclear reactors. At the present time 75 educational institutions offer programs in nuclear engineering, including 29 baccalaureate, 70 master, and 48 doctoral programs. In addition, 5 institutions offer training in nuclear technology at the two-year associate degree level. The general nature of each of these types of programs is discussed along with needs and criteria for their effective implementation. Attention is also given to current and expected trends in manpower needs. Emphasis is placed on the need for educators to be alert to the changing character of the nuclear field so that their curricula and their graduates can keep pace with new developments. 12 references. (auth)

39132 (A/CONF.49/P-723) ENERGY-ENVIRONMENTAL EQUATION. Larson, Clarence E.; Brown, Howard C. Jr. (Atomic Energy Commission, Washington, D. C.). Sep 1971. 21p. (CONF-710901-25). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The crucial role of nuclear power in meeting the energy demands of the future is examined. The public-acceptance problems that have been encountered in attempting to assess the environmental effects of nuclear power generation are discussed. Current estimates of nuclear power growth are examined in the context of projected requirements for increased electrical generating capacity, the gradual depletion of fossil-fuel reserves, and the alternatives. The extent to which nuclear fuels will extend the world's energy stores for hundreds of years is examined and documented. Data are presented to show that the breeder reactor will enhance the position of nuclear power from both an economic and an environmental standpoint. The breeder will ensure an unlimited source of reliable low-cost power and will offer decided advantages in contributing to a cleaner environment. Environmental problems are viewed in a global context. Public attitudes toward the environmental effects of nuclear power are examined. 8 references. (auth)

39133 (A/CONF.49/P–833) GAS-COOLED REACTOR DEVELOPMENT IN THE UNITED STATES. Landis, J. W. (Gulf General Atomic Co., San Diego, Calif.); Everett, J. L. (Philadelphia Electric Co., Pa.); Walker, R. F. (Public Service Co. of Colorado, Denver); O'Rorke, E. W.; Rickard, C. L.; Fortescue, P.; Goodjohn, A. J. (Gulf General Atomic Co., San Diego, Calif.); Trauger, D. B. (Oak Ridge National Lab., Tenn.). Sep 1971. 17p. (CONF-710901–26). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The design of the first commercial 1100-MW(e) high-temperature gas-cooled reactor (HTGR) is described with reference to the developments that provided the basis for the scale-up from the 330-MW(e) Fort St. Vrain Station. Improvements include a wire-wound, multicavity prestressed-concrete reactor vessel, six instead of two steam-generator loops, and a structurally independent secondary containment. Arrangement of the steam generators in wells within the vessel wall at the level of the core was motivated by the need to provide improved accessibility for maintenance and repair and to decrease overall plant elevation for increased seismic resistance. Steam conditions of 2400 psi and 950°/1000°F result in a net plant efficiency of about 40%. Recent developments in plant components and safety are discussed, including prestressed-concrete reactor vessels, fission-product deposition tests, and a system for minimizing radioactive effluent. Design and development work under way on 750- and 1600-MW(e) HTGR's and on-line refueling is described. Concern about effects of heated effluents has greatly accelerated interest in the use of the HTGR with the closed-cycle gas turbine. Studies along this line have been directed toward waste-heat rejection through dry cooling towers to eliminate both water consumption and thermal effects with minimal economic penalty. Preliminary design work on 1000-MW(e) gas-cooled fast breeder reactor (GCFR) systems indicates the possibility of achieving a specific core inventory of approximately 2.2 kg/MW(e) and a breeding ratio of 1.5, leading to a doubling time of about seven years, with mixed-oxide fuel operating at about 750°C hot-spot clad temperature. Fast reactor safety work, including analysis of loss of pressure and/or primary-coolant circulation, has confirmed that these conditions can be accommodated. Irradiation experiments at Oak Ridge National Laboratory and in Experimental Breeder Reactor No. II, including tests of the vented fuel concept, are reported. The preliminary design of a 300-MW(e) demonstration plant, carried out in cooperation with 44 utility companies, is described. The ultimate potential of gas-cooled breeders in combination with closed-cycle gas turbines is also discussed. 30 references. (auth)

39134 (CONF-710416) PAPERS PRESENTED AT THE SYMPOSIUM ON TRAINING OF NUCLEAR FACILITY PERSONNEL, GATLINBURG, TENN., APRIL 19–21, 1971. (Oak Ridge National Lab., Tenn.). 407p. Dep. NTIS.

Information concerning nuclear power plant personnel and public relations is presented under the following main headings: training objectives and philosophy; qualifications and staffing; training methods; special topics; and training and public acceptance. Separate abstracts are included for each of the 22 papers presented. (D.C.C.)

For abstracts of individual papers see: 37456, 37457, 39135–39138, 39183, 39184, 39213–39224, 39286, and 39287.

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39135 (CONF-710416–, Paper 2) UTILITY TRAINING PHILOSOPHY. Haueter, Robert L. (Consumers Power Co., Jackson, Mich.). 8p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

The training philosophy for personnel of the Palisades Power Reactor is described. (D.C.C.)

39136 (CONF-710416–, Paper 13) OPERATOR TRAINING AT SEQUOYAH NUCLEAR PLANT. Ballentine, Jere M. (Tennessee Valley Authority, Knoxville). 7p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

39137 (CONF-710416–, Paper 21) PLANNING FOR NUCLEAR PUBLIC ACCEPTANCE. Sturgeon, E. F. (Northeast Utilities, Springfield, Mass.). 20p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

A public relations program for gaining public support of nuclear power plants in the U. S. is described. (D.C.C.)

39138 (CONF-710416–, Paper 22) TRAINING OF UTILITY REPRESENTATIVES IN THE FIELD OF PUBLIC ACCEPTANCE OF NUCLEAR POWER. Matheney, G. B. (Consumers Power Co., Jackson, Mich.). 18p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

39139 (CONF-710512–6) IN-SERVICE INSPECTION OF SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Hornbuckle, J. D.; Baskin, K. P. (Southern California Edison Co., Los Angeles); Lautzenheiser, C. E.; Hendricks, H. E. (Southwest Research Inst., San Antonio, Tex. Dept. of Materials Engineering). 12 Feb 1971. 9p. (71-PVP-51). ASME, New York $2.00.

From first national congress on pressure vessels and piping; San Francisco, Calif. (10 May 1971).

Southern California Edison Company (SCE), with the aid of its consultant, Southwest Research Institute developed a comprehensive program for in-service inspection of the primary coolant system of the San Onofre Nuclear Generating Station, Unit 1. The first in-service inspection was conducted during the October 1970 refueling outage. The results of the inspection are described together with the problems associated with radiation levels and geometric interferences. With the exception of the Reactor Coolant Pump "C" flywheel, and the indications found on the steam generator B-inlet and C-outlet nozzle to safe-end welds, the results of the October 1970 in-service inspection revealed the examined areas to be free of defect indications beyond ASME Boiler and Pressure vessel code standards. The data obtained from the in-service inspection will provide a base line reference for future monitoring of plant performance. (auth)

39140 (CONF-710512–13) NUCLEAR CODE CLASS, SAFETY CLASS, AND QUALITY ADMINISTRATION; HOW THEY TIE TOGETHER. Seth, W. B. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). 12 Feb 1971. 7p. (71-PVP-56). ASME, New York $2.00.

From first national congress on pressure vessels and piping; San Francisco, Calif. (10 May 1971).

The Atomic Energy Commission in their General Design Criteria for Nuclear Power Plants Construction Permits set criteria for the power plants with the intent that industry would prepare codes and standards to implement these General Design Criteria. The 1971 ASME Boiler and Pressure Vessel Code Section III, Rules for Construction of Nuclear Power Plant Components, defines three levels of "quality" in the code classes for pumps, valves, pipes, and vessels but looks to systems safety criteria for guidance in selection of the appropriate code class for a specific application. The American Nuclear Society has developed their Nuclear Safety Criteria for the Design of Stationary Pressurized-Water Reactor Plants which identifies safety classes for safety related systems in a pressurized-water reactor plant and correlates the code class to the safety class. The applications of the correct ASME CODE Class to the ANS Safety Class and of Quality Administration (how sure you are that you got the quality you asked for) to justify the use of appropriate code class equipment in specific safety class systems are described. (auth)

39141 (DOCKET-50237–176) DRESDEN NUCLEAR POWER STATION, UNIT 2. Report No. 5: Fuel Inspection and Evaluation. (Commonwealth Edison Co., Chicago, Ill.). 4 Jun 1971. 13p. Dep. NTIS.

The operations performed during a March 1971 inspection of fuel rods suspected of leaking are described. The inspection resulted in the removal of 215 fuel assemblies because of confirmed leakage, suspicious data, or statistical evaluation of potential leakage. (H.D.R.)

39142 (IAEA–117, Paper 5a) SURVEILLANCE PROGRAMMES OF REACTOR PRESSURE VESSELS (NETHERLANDS REVIEW PAPERS). Latzko, D. G. H. (International Atomic Energy Agency, Vienna (Austria)). 1970. 7p. (CONF-690727–9). NTIS (U. S. Sales Only).

From Report of a meeting of specialists; Tokyo, Japan (21 Jul 1969).

The necessity for surveillance programs of reactor pressure vessels is generally acknowledged in the Netherlands. Therefore an extensive program is foreseen for the first Dutch nuclear power station, a 50 MW(e) boiling water reactor unit, scheduled for commissioning in 1968. The scope of the surveillance program is summarized and a comparison is made of the results from various basic research programs on: the influence of metallurgical variables, the radiation sensitivity of pressure vessel steels, the behavior of irradiated steels under alternating stress and after long-term stress relieving heat treatment and the effects of irradiation and post-irradiation annealing. (INIS)

39143 (IAEA–117, Paper 6) SURVEILLANCE TEST OF JAPAN POWER DEMONSTRATION REACTOR (JPDR). Masayuki, Kawasaki; Tadato, Fujimura (International Atomic Energy Agency, Vienna (Austria)). 1970. 14p. (CONF-690727–7). NTIS (U. S. Sales Only).

From Report of a meeting of specialists; Tokyo, Japan (21 Jul 1969).

The Japan Power Demonstration Reactor (JPDR) has operated for a total of 9,040 hr (16,931 MWd) at the equivalent full power. JAERI is proceeding with the project of doubling the power of JPDR. In order to confirm the integrity of its pressure vessel concerning the neutron irradiation embrittlement, JAERI performed three surveillance tests. From the results of the surveillance tests described with regard to the shift of transition temperature and the decrease of upper-shelf energy, it is shown that the pressure vessel would last for the next ten years at full power operation. (INIS)

39144 (IAEA–119, 4p.) ELECTRICAL SURGES, TRANSIENTS, AND INTERFERENCE IN NUCLEAR REACTOR ENVIRONMENTS. Harrison, D. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–16). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The development of methods of testing for interference susceptibility is reviewed. A general method of overall testing has been devised, using controlled disturbances and CRT displays. More detailed techniques using current and voltage probes have been developed for study of the interference environment. Measurement of surges and transients so that characteristics of these disturbances can be expressed statistically for typical plant situations is described. (INIS)

39145 (IAEA–119, 5p.) FLUX MEASUREMENT IN THE EL-4 REACTOR USING NEUTRON ELECTRON CONVERTERS. Lourme, P. (International Atomic Energy Agency, Vienna (Austria)). 1970. (In French). (CONF-691116–21). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

39146 (IAEA–119, 5p.) SHORT SUMMARY OF ACTIVITIES IN THE ELECTRONICS DEPARTMENT PREPARED FOR AN IAEA PANEL ON "INSTRUMENTATION FOR NUCLEAR POWER PLANT CONTROL" IN VIENNA 1969. Timmermann, P. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–29). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The program of Danish activities in the field of instrumentation for nuclear power plant control covers some areas of reactor instrumentation exploring man-machine communication and safety aspects of modern instrumentation systems. The composition of the research work gives rise to a considerable effort on development of measuring equipment for neutron-physics experiments and in-core test rigs. (INIS)

39147 (IAEA–119, 6p.) DIFFICULTIES ENCOUNTERED IN THE NEUTRON POWER MEASUREMENT OF THE EL-4 REACTOR, USING IONIZATION CHAMBERS SITUATED OUTSIDE THE CORE. Lourme, P. (International Atomic Energy Agency, Vienna (Austria)). 1970. (In French). (CONF-691116–23). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

39148 (IAEA–119, 7p.) EFFECT OF THE FUTURE OPERATING ROLE OF NUCLEAR POWER REACTORS ON INSTRUMENTATION AND CONTROL HARDWARE. Butterfield, M. H. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–6). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

Up to the present, most nuclear power stations have been considered as operating under base-load conditions. As the proportion of nuclear power in a generating system's total output increases, it is clear that nuclear power must play an increasingly important role in load following. The effects of this changing role will be quite important in the control and instrumentation field. The design criteria and hardware requirements for load following control systems and instrumentation are described. (auth)

39149 (IAEA–119, 7p.) NEUTRON FLUX MEASUREMENT OF THE REACTORS AT WUERGASSEN AND STADE. Haebler, D. von (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–15). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

For the reactor at Gundremmingen the neutron flux instrumentation in the power range consists of both in-core and out-core instrumentation, all signals for automatic control being derived from the out-core instrumentation and the in-core instrumentation supplying signals. Reliable stationary neutron flux supervision in the core with adequate local resolution is a step forward since it also renders possible protection of the reactor against local power peaks. (INIS)

39150 (IAEA–119, 8p.) INSTRUMENTATION FOR NUCLEAR POWER PLANT CONTROL. SOME ASPECTS OF THE PRESENT STATE OF EXPERIENCE AND PROGRAMME IN BELGIUM. Maere, G. de; Mathieu, F.; Vanhaelewijn, R. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–24). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

A summary of the work which is being performed by several groups in Belgium in the field of instrumentation for nuclear power plant control is presented. The information presented only partially covers the experience which has been gained and the programs which have been set up in this field. (INIS)

39151 (IAEA–119, 9p.) ON-LINE NOISE ANALYSIS OF REACTORS WITH THE POLARITY CORRELATION METHOD. Dio, W. H. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–8). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The first results of on-line noise measurements on the Obrigheim Power Reactor which were carried out during commissioning are presented. The main purpose of these measurements is to gain first-hand experience of the possibilities and practical use of correlation measuring methods on power reactors. (INIS)

39152 (IAEA–119, 9p.) ON-LINE NOISE ANALYSIS AT THE KWO POWER REACTOR BY USING POLARITY CORRELATION. Dio, W. H.; Haebler, D. von (International Atomic Energy Agency, Vienna (Austria)). 1970. (In German). (CONF-691116–9). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The polarity correlation function for noise analysis uses only the changes in sign of the variable. The function can be substituted under certain assumptions in the place of the normal correlation coefficient. Measuring equipment with digital scan of the signals and replacement of the integration by a summation can be easily designed. Applying this apparatus to the neutron flux measuring channels at the 280 MW(e) KWO PWR showed periodic fractions in the autocorrelation function probably generated by mechanical vibrations of the detectors and resonance lines in the cross spectral density of 2 detectors not yet fully understood. (INIS)

39153 (IAEA–119, 11p.) DISCRETE MONITORING OF THE IN-CORE POWER DISTRIBUTION IN NUCLEAR REACTORS. Emelyanov, I. Ya.; Konstantinov, L. V.; Postnikov, V. V. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–10). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

A brief survey of methods of monitoring the power distribution in reactors at Soviet nuclear power stations is presented. Two techniques for calculating the power distribution based on discrete in-core measurements consist of: an empirical method and a combined theoretical-experimental method. The former is based on simple relationships derived from experimental research. The second method involves a simultaneous application of physical calculations and discrete measurements of power distribution fields. The metrological characteristics of the techniques are given, and the relationship between reliability, permissible power and error in measurements of fuel channel power is discussed. (auth) (INIS)

39154 (IAEA–119, 12p.) INSTRUMENTATION AND CONTROL FOR CANADIAN NUCLEAR REACTORS. Davis, G. T. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–7). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The development and current state of the art in the areas of reactor power regulation, failed fuel location systems and fuelling machine control for Canadian nuclear reactors are reviewed. All fuelling machine control systems of recent design use digital computer control. As might be expected with three different design groups, the design details differ. The suitability of digital control has been well proven. (INIS)

39155 (IAEA–119, 12p.) METHODS AND INSTRUMENTATION FOR ANALYSIS AND CONTROL OF THE MARVIKEN NUCLEAR POWER PLANT. Tuxen-Meyer, H.; Josefsson, R.; Schuck, N.; Aakerhielm, F. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–28). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The Marviken reactor is designed as a direct-cycle boiling heavy water reactor with natural circulation and a power output of 140 MW(e) at saturated steam operation and 49.5 bar pressure. In the design stage the dynamic behavior of the reactor core and the plant as a whole was simulated on the analogue computer PACE 231 R in order to study the degree of plant stability and to allow an optimization of the automatic reactor control system. The study presented demonstrates that it may be important to perform dynamic simulations early in the design procedure, as the results of parameter studies may propose modifications in the design. (INIS)

39156 (IAEA–119, 13p.) DEVELOPMENTS, EXPERIENCES, AND TRENDS OF INSTRUMENTATIONS FOR POWER REACTOR CONTROL IN JAPAN. Shozo, Shimomura; Yoshikuni, Shinohara (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–27). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

A brief survey of the recent activities in Japan concerning the development of instrumentation for nuclear power reactor control is given. The activities are summarized with regard to the following three major categories: out-of-pile standard nuclear channel instrumentation; in-core instrumentation; improved techniques and instruments which are not standard yet but will be so in the future power reactors. (INIS)

39157 (IAEA–119, 13p.) INSTRUMENTATION FOR NUCLEAR POWER PLANT CONTROL IN CZECHOSLOVAK SOCIALIST REPUBLIC. Wagner, K.; Kovanic, P.; Stirsky, P. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–30). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The results and plans of research, development, and supplying activities for instrumentation in nuclear power plant control in Czechoslovakia are presented. (INIS)

39158 (IAEA–119, 15p.) INSTRUMENTATION, CONTROL, AND PROCESS, COMPUTERS IN GERMAN POWER REACTOR PLANTS. Bastl, W. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–4). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

A survey of the present state in instrumentation, control, and process computers of nuclear power plants in the Federal Republic of Germany is presented. (INIS)

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39159 (IAEA–119, 15p.) SOME CONSIDERATIONS ON REACTOR INSTRUMENTATION, CONTROL, AND SAFETY. Keddar, A. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–19). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

Due to the increase in size and to the high performance required of the nuclear power stations, control systems have become increasingly complex, and the instruments should receive priority to improve their reliability. Therefore special care should be taken as to the control, supervision, testing and protection of the installation when large power stations are being built near centers of population. The recent development of in-core instrumentation showed the great importance of continuing it for economical and safety purposes; by now all large nuclear power plant designs include in-core instrumentation for determining important reactor parameters. (INIS)

39160 (IAEA–119, 16p.) DEVELOPMENT OF SELF-POWERED HIGH-FLUX NEUTRON DETECTORS AND THEIR APPLICATIONS IN POWER REACTORS IN SWEDEN. Jonsson, G.; Strindehag, O.; Soederlund, B. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–18). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

Development of self-powered high-flux neutron detectors and their applications in power reactors in Sweden are presented. Self-powered detectors may be generally defined as detectors which can function for their purpose without an external high-voltage supply. Assuming that this definition embraces various thermocouple and semiconductor devices for the detection of radiation, there is need for a more specific term for one class of self-powered neutron detectors which utilize (n,β) or (n,γ^e) reactions. Such detectors are called beta-current detectors. The investigation of vanadium and cobalt detectors done so far, has demonstrated that both these detector types can be used for in-pile flux monitoring in power reactors. (INIS)

39161 (IAEA–119, 21p.) REPORTS ON OUT-OF-CORE MEASUREMENTS, REACTOR PROTECTION, FUNCTIONAL GROUP CONTROL AT HDR. Wirth, W. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–33). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The design and extent of out-of-core instrumentation with fully transistorized units at the Grosswelzheim HDR superheat reactor correspond to the usual design for boiling water reactors. The statistics on the overall nuclear instrumentation of KRB supplies the following information for the period from April 1968 to September 1969: three cold soldered junctions gave rise to failures of instruments, 34 failures were recorded for semiconductors and 4 with electrometer tubes; the disturbances of other structural components amounted to 10. (INIS)

39162 (IAEA–119, 29p.) IN-CORE INSTRUMENTS USED IN THE HALDEN BOILING HEAVY WATER REACTOR, APPLICATIONS AND PERFORMANCE. Aarset, B. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–2). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

In the Halden Boiling Heavy Water Reactor considerable experience has been gained in the application of in-core instruments, and valuable information has been obtained on dynamic behavior of the reactor and fuel assemblies, on temperature and heat transfer limitation of the fuel, on fuel and fuel can expansion and interaction, on fission gas pressure development, and on gamma and neutron flux distribution. Instruments used are turbine flow meters, thermocouples, gamma thermometers, neutron thermometers, self-powered neutron detectors with vanadium and cobalt absorbers, an aeroball system, fission gas pressure transducers, differential transformer extensometers, void gauges, various types of burn-out detectors, strain gauges, and electromagnetically and pneumatically controlled valves. A data handling system based on access to a larger process computer is used for the experiments. In-core applications of various instruments in power reactors are discussed. (INIS)

39163 (IAEA–119, 29p.) INSTRUMENTATION FOR NUCLEAR POWER PLANT CONTROL. Moore, V. A. Jr. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–26). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

A summary of the present situation of the work in USA in the field of instrumentation for nuclear power plant control is presented. Since water reactors constitute such a large majority of US power reactors, this survey of US power reactor instrumentation practice is limited to pressurized water reactors and boiling water reactors. (INIS)

39164 (LB/G–3024) ORGANISATION OF EXPERIMENTAL WORK ON FUEL-ELEMENT TESTING AT THE FIRST ATOMIC POWER STATION REACTOR. Konochkin, V. G.; Sever'yanov, V. S.; Kochetkov, L. A.; Kozlov, V. Ya. ([Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut]). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from a Russian report. 23p. (CONF-691060–10). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

Handwritten MS copy.

Design modifications for the Obninsk Power Reactor to convert to a fuel-testing reactor are described. Operations aspects of the modified reactor are analyzed. (3 references) (D.C.C.)

39165 (LIB/Trans–353) COMMISSION FOR THE ASSESSMENT OF THE RCN PROGRAMME. Boettcher, C. J. F. ([Reactor Centrum Nederland, The Hague]). Translated by H. Groenewegen (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from a Dutch report. 33p. Dep. NTIS (U. S. Sales Only).

An account is given of recommendations made by the Commission for the assessment of the Reactor Centrum Nederland program. The Commission's terms of reference were to advise the Minister for Economic affairs regarding the possibilities of making the activities of RCN more strongly attuned to the expected intermediate term requirements of industry and the electricity authorities; and regarding the possibilities of limiting the cost to the government, of these activities. This is done in the context of the history of RCN, and its projected lines of development. Some recommendations on the structure and administration of RCN are presented, and details are given of current activities and the purpose of the work involved. (Australia)

39166 (WCAP–3017-6094) YANKEE CORE EVALUATION PROGRAM, FINAL REPORT. Melehan, J. B. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Jan 1971. 148p. Dep. NTIS.

Two advanced SENA-type fuel assemblies were designed and fabricated by Westinghouse under contract with Yankee Atomic Electric Company and irradiated in Yankee–Rowe Core V. The original purpose of the irradiation and post-irradiation examination program was to evaluate the assembly mechanical design and the performance of UO_2 fuel rods clad with stainless steel and Zircaloy-4. Because of schedule and budgetary constraints, the program technical activities were restricted to the evaluation of removable Zircaloy-clad fuel rods which were removed from the assemblies prior to reprocessing. The arrangement of rods in the two assemblies is illustrated. The majority of the fuel rods were clad with Zircaloy-4. Twenty-eight rods were designed to be removable from the assemblies for post-irradiation examination. The majority of the removable rods were Zircaloy-clad. The Zircaloy-clad rods were about 97 inches long, 0.362 inches outside diameter with 0.021 inches thick Zircaloy clad. All rods were loaded with 94 percent dense 2.9 percent enriched fuel pellets. The assemblies were irradiated in the D7 and G4 core positions. The irradiation began in November 1965 and was ended in October 1966 when inspection at the end of Core V revealed buckling of the assembly enclosures. Pertinent design and operating data for the assemblies are listed. Several months after Core V shutdown, the 28 removable fuel rods were given a limited non-destructive examination at the reactor site. The examination consisted of general visual inspection and gamma scan measurements to determine relative burnup and axial burnup profiles. (19 references) (auth)

39167 TVA BROWNS FERRY NUCLEAR PLANT. Ind. At.; 15: No. 1, 31-8(Mar-Apr 1971). (In English and French).

The design and layout of the Browns Ferry Nuclear Plant, with a capacity of 3,152,000 kilowatts, now under construction on Wheeler Reservoir of the Tennessee River are discussed. Particular attention is devoted to the reactors, the turbine-generators, and control of the plant, as well as the specially designed diffuser system for discharging the condenser cooling water. (France)

39168 USE OF SIMULATION PLUS REAL STEAM TURBINE FOR TEACHING THEORY AND OPERATION OF A PRESSURIZED WATER REACTOR. Schultz, M. A. (Pennsylvania State Univ., University Park); Eckley, Wayne F. Nucl. Technol.; 10: No. 3, 380-90(Mar 1971).

In teaching the theory and operation of a PWR, a method was developed which makes use of an analog computer primary loop simulation and a secondary loop consisting of a real steam turbine-generator set. The analog is fitted with a reactor kinetics network and a transport delay unit with memory capacitors. Potentiometer settings at the analog originate at the real turbine as temperatures and pressures of the saturated steam at 215 psia. Students consult steam tables, Mollier charts, etc. to obtain correct values for points at the interface, secondary side of the heat exchange. The "pinch point" concept of heat transfer is used to transfer data across the heat exchanger to the primary loop. The proper potentiometer settings at the analog result from this "pinch point" and the design criteria for half load or full load operating condition existing at the turbine. Two dynamic variations are made from the "steady-state" half load run. One of these is a "sudden" throttle opening at the turbine; the other is a "step" reactivity insertion made at the reactor (analog). Students make adjustments for the revised settings in both loops. The experimental setup and a series of dynamic experiments are described. (auth)

39169 PREDICTION OF THREE-DIMENSIONAL CORE PERFORMANCE OF JPDR (A BWR) FOR BURNUP CASES. Shimooke, T. (Japan Atomic Energy Research Inst., Tokai). Nucl. Technol.; 10: No. 3, 257-72(Mar 1971).

Various core performances, such as power and void distributions, reactivity change, and shifts of control rods, are predicted for the JPDR-1 in a three-dimensional framework by means of the one-energy-group, coarse-mesh approximation of the BWR core. The predictions are checked in detail with experimental data which were accumulated by the core-performance assessment experiments done throughout the life of the JPDR-1 core. The data includes, γ-probe data of the core at the exposure of each 1000 MWD/T, core outlet void fractions measured directly by void-meters, logbook records of the control rods patterns, heat-balance data for the precise core-outputs, and others. The one-energy group, coarse-mesh approximation is proved to be satisfactory for describing the global core performances of the JPDR-1 for burnup cases. The global power distributions can be calculated with 4% standard deviation in the channel power sharing, and this is accurate enough to predict the core-reactivity within 0.3% Δ k/k error at 6000 MWD/T exposure. The observed discrepancy 0.9% Δ k/k in the core-reactivity at 6000 MWD/T exposure (i.e., 10–15% error of the burnup change of reactivity) is discussed with the final suggestion that the local power and exposure distribution in a core should be studied first for better achievement of the global core description. (16 references) (auth)

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Refer also to abstract 37536.

39170 (A/CONF.49/P–36) OPERATING EXPERIENCE WITH COMMERCIAL CENTRAL STATION LIGHT WATER REACTORS IN THE UNITED STATES. Roddis, Louis H. Jr. (Consolidated Edison Co. of New York, Inc., New York); Ward, J. Harris (Commonwealth Edison Co., Chicago, Ill.). Sep 1971. 23p. (CONF-710901–47). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The operating experience of U. S. light-water central-station nuclear power plants since 1964 is examined. During the accumulation of almost 100 reactor-years of operating experience, operational and component problems have been diverse. The economics and technical difficulties associated with solving start-up and breakdown problems are presented. Data on nuclear-power-plant availability and the effect on total utility-system operations are also presented. During 1969, U. S. reactor availability varied from 51.5 to 95.4%. The problems experienced in operating the lower efficiency reactors and the solutions to these problems are discussed. Experience with various components, materials, and operational procedures as well as reactor availability during peak demand periods are evaluated and documented. During 1970 and the first part of 1971, several large water reactors in the 1000-MW capacity range will be brought into operation. Information on operating and start-up problems unique to the large reactors is included. Operational information is reviewed from specific commercial central-station light-water nuclear reactors. 8 references (auth)

39171 (A/CONF.49/P-37) FACTORS AFFECTING HISTORICAL AND PROJECTED CAPITAL COSTS OF NUCLEAR POWER PLANTS IN THE UNITED STATES. Vann, H. E. (United Engineers and Constructors Inc., [Philadelphia, Pa.]); Whitman, M. J. (Division of Reactor Development and Technology (AEC), Washington, D. C.); Bowers, H. I. (Oak Ridge National Lab., Tenn.). Sep 1971. 15p. (CONF-710901-33). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Historical trends in the capital cost of nuclear power plants can be readily identified by a rising curve starting at 125 $/kW in the mid-1960's to over 300 $/kW in the beginning of the 1970's. Although this rise in capital costs represents a substantial escalation in cost over a relatively brief span of time, it is significant to note that the differential costs between fossil and nuclear plants have remained fairly constant. Many factors are involved in these cost trends. The most significant of these are: incomplete nature of early estimates related to limited experience, escalation of safety and quality-assurance requirements, escalation of labor rates and labor content, escalation of interest rates for construction funding, and lengthening of project schedules. In projecting the future trends of nuclear plant capital cost in the U. S., one is faced with a wide range of variables, including the emotional and psychological mood of the general public relative to acceptance of nuclear power in consideration of postulated biological and environmental effects. Factors related to public concern have contributed to lengthened construction schedules and increased costs of manufactured components and field construction. The integrated effect of these many variables will, no doubt, lead to a continued rise in capital costs of nuclear power plants; however, compensating influences can be readily identified in the capital- and fuel-cost trends for fossil plants. In evaluating these principal variables, it is concluded that, although capital costs of nuclear plants have risen substantially and will probably continue to rise, compensating elements in the overall electric-energy pattern indicate that a vigorous growth rate can be expected to continue for nuclear power in the U. S. 3 references. (auth)

39172 (A/CONF.49/P-42) INTEGRATING NUCLEAR POWER INTO PLANNING FOR POWER-SYSTEM OPERATION. Gilleland, J. E. (Tennessee Valley Authority, Chattanooga, Tenn.); Behnke, Wallace B. (Commonwealth Edison Co., Chicago, Ill.); Whitman, Merrill J. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Sep 1971. 8p. (CONF-710901-3). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

With the coming of the large-scale use of nuclear power plants employing batch-loaded fuel cycles, electric utility management is faced with the challenge of integrating the planned operation of these plants into power-system operation. In the past it has been possible to perform operational planning for nuclear units largely independent of the constraints imposed by an optimal overall power-system operation. As the number of nuclear units on a power system increases, it is essential to fully integrate operational planning of the nuclear plants into the system to minimize system production cost. This requires the development of an effective analytical model for planning power-system operation. A joint effort to develop new methods for planning optimal operation to lower the delivered power cost of a mixed (nuclear, fossil, and hydro capacity) power system is described. The optimization involves a continuing economic appraisal of the effect on future power costs of various alternative courses of action based on the current state of the power system. It requires an appraisal of expected future performance of existing fuel in each reactor and its interaction, on a system basis, with future fuel loading and consideration of in-core fuel-management restraints. Account must be taken of system reliability and future uncertainties of system energy and demand requirements and forced outages and deratings of capacity. The operating limits of equipment, permissible refueling periods, maintenance scheduling, and the limitations and flexibility in procuring and scheduling of fuel-cycle materials and services are essential considerations. The objective is to develop a model that will determine the optimum strategy for managing and programming power-supply resources in meeting system power requirements at the lowest overall power cost. 4 references. (auth)

39173 (A/CONF.49/P–72) U. S. CIVILIAN NUCLEAR POWER COST-BENEFIT ANALYSIS. Whitman, M. J.; Tardiff, A. N. (Division of Reactor Development and Technology (AEC), Washington, D. C.); Hofmann, P. L. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1971. 16p. (CONF-710901–14). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A substantial investment of national resources is required to introduce a new method of electric-power production into the commercial utility environment; therefore it is imperative that methods be established to evaluate the choices available. A linear program model of the U. S. electric-power economy was developed as an aid in comparing the costs and benefits implicit in decisions that affect the U. S. Civilian Nuclear Reactor Program. The model optimizes the U. S. electric-power economy for minimum total costs over the

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50-year period from 1970 to 2020 A.D. by selecting the type of power plant to be constructed and the rate at which these plants are introduced. The nuclear power plants considered in the study were light-water reactors, high-temperature gas-cooled reactors, and liquid-metal-cooled fast breeder reactors. The performance characteristics of each nuclear-plant type were considered, including the utilization of U, Pu, and Th, separative-work requirements, and fuel-cycle costs as a function of fuel throughput for each reactor type. In the analysis it was necessary to project the growth in demand for electric power, the capital and operating costs of nuclear- and fossil-fueled plants, the cost–availability relationship of nuclear fuel, and the cost trends for fossil fuel. Parametric studies were made to examine the sensitivity of the cost–benefit ratio to such key factors as energy demand, the date of introduction of the fast breeder reactor, and the cost of uranium. It is concluded that the increased dollar benefits to be obtained through the early introduction of the liquid-metal-cooled fast breeder reactor provide the incentive to justify the research and development program necessary to ensure its early commercial viability. The benefits are sufficient to also justify the cost of a parallel development program for an alternate breeder concept. Continuing refinement of the model will allow more detailed consideration of variables including regional variations in factors affecting power costs and the impact of events such as the increased public concern over the environmental effects of power-plant effluents. 11 references. (auth)

39174 (DOCKET-50219–138) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. High Drywell Pressure Sensor Reset Failure. (Jersey Central Power and Light Co., Morristown, N. J.). 14 Jun 1971. 2p. Dep. NTIS.

39175 (DOCKET-50237–180) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Secondary Containment Leak Rate Test Summary. (Commonwealth Edison Co., Chicago, Ill.). 10 Jun 1971. 4p. (DOCKET-50249–75). Dep. NTIS.

39176 HEALTH PHYSICS CONSIDERATIONS. Martin, J. J. (Electricite de France, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 83, 38-42(Jan-Feb 1971). (In French).

Two important working areas associated with the Chooz reactor are described: the high activity working area; the water vapor generator area. Operations on parts inside the tank benefit from the protection offered by the water; this shielding is sufficient to eliminate all risks to working personnel. The construction of the generators is such that liquids can be used for their decontamination. At the time of the incident with the St-Laurent-des-Eaux reactor, the following radioprotection problems presented themselves: control of pollution and radiations, examination of possibilities of access by personnel into the controlled zone, examination of the possibility of disposing contaminated CO_2, and measurements of the degree of exposure inside the reactor. (France)

39177 REPAIR OF THE CHOOZ REACTOR. Kieffer, J. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); 83: 17-37(Jan-Feb 1971). (In French).

The components of the reactor are described. Incidents which arose in 1968 during the operation of the primary circuit are analyzed: disequilibrium of the thermal screen inducing to and fro motion and producing stresses in the core skirt; and the rupture by fatigue of the brace rods. A study of the repairs to be carried out led to the elimination of the thermal screen and the brace rods, the overhaul of the joint between the two core skirts, the checking of the fuel load, and the prevention of deterioration to the tubular plates of the steam generators. The distribution of the active parts in the pool of the reactor resulted in an excellent protection for workers operating at close distances. Some equivalent dose values measured in the course of the work are given. The methods of inspecting the nuclear fuel and of decontaminating the steam generators using liquids are presented. Information relative to the operation of the plant, the repair equipment, and the methods of repair was obtained from these investigations. (France)

39178 WORKING EXPERIMENT IN ACTIVE ENVIRONMENT AT THE SAINT-LAURENT-DES-EAUX POWER PLANT. Knockaert, A.; Grauvogel, A. (Electricite de France, Saint-Laurent-des-Eaux, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 83, 9-16(Jan-Feb 1971). (In French).

During the fuel loading process, a piece of graphite was substituted for a fuel element in the upper part of the channel. The resulting heating effects led to the distribution of fifty kg of U in the primary circuit and the carrying into the lower part of the reactor vessel of part of this U (floor, support area, exchangers) and the serious contamination of the reactor with very fine dusts. The general environmental conditions under which the various repair operations were carried out are discussed: remote operation from the exterior of the reactor vessel for estimating the damage and extracting the largest pieces of debris; the cleaning and repairing of lower parts of the channel by direct access beneath the reactor; and the positioning of the filters in the primary circuit. (France)

Safety and Siting

Refer also to abstracts 37567 and 37829.

39179 (A/CONF.49/P–38) REGULATORY PERSPECTIVES AND EMPHASIS AND SAFETY EXPERIENCE FOR NUCLEAR POWER REACTORS. Beck, Clifford K.; Denton, Harold R.; Morris, Peter A.; Thompson, Dudley (Atomic Energy Commission, Washington, D. C.). Sep 1971. 20p. (CONF-710901–1). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The formal procedures for safety reviews by the U. S. Atomic Energy Commission (AEC) of applications for construction permits and operating licenses for nuclear power reactors are discussed. These procedures, initiated in the late 1950's, have been evolving with time as more experience and changing conditions have come about. Similarly, with many larger reactors of more advanced design, new developments have occurred in the scope and depth of the safety reviews. The developments of the last few years with respect to procedural changes and safety questions of special interest are described, and a brief summary of the experience with operation of licensed nuclear power plants in the U. S. is presented. 9 references. (auth)

39180 (A/CONF.49/P–43) ROLE OF CODES AND STANDARDS IN ACHIEVING SAFE, DEPENDABLE, AND ECONOMIC NUCLEAR POWER. Joslin, Murray (Consultant); Lee, William S. (Duke Power Co., Charlotte, N. C.); Bender, Myer (Oak Ridge National Lab., Tenn.); Landis, John (Gulf General Atomic, Inc., San Diego, Calif.); Case, Edson (Division of Reactor Standards (AEC), Washington, D. C.); Rosen, M. A. (Division of Reactor Development and Technology (AEC), Washington, D. C.); Ramey, James T. (Atomic Energy Commission, Washington, D. C.). Sep 1971. 13p. (CONF-710901–4). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The current nuclear standards program is described, which particular emphasis on organization and procedural features designed to expedite standards production. It includes the standards organizations of the technical societies that do the vast bulk of standards drafting and updating work. Statistics showing the number of workers supplied by various sectors of industry and government are included. Methods by which priorities are established and progress in the principal priority efforts are indicated. The various ways in which the USAEC is supporting the program are also described. (auth)

39181 (A/CONF.49/P–86) BIOLOGICAL COST OF DISCHARGING HEAT TO RIVERS. Foster, R. F.; Jaske, R. T.; Templeton, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1971. 10p. (CONF-710901–21; BNWL-SA–3650). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In view of the widespread conjecture that the addition of cooling water to rivers entails a substantial biological cost, comprehensive studies are being made both under controlled laboratory conditions and on major rivers of the U.S. to determine whether adverse effects actually occur. These studies include: those carried out over a period of 25 years by the USAEC on the Columbia River in the Pacific Northwest, which is noted for salmon and is used to cool plutonium-production reactors; the Connecticut River in New England, noted for shad and used to cool a series of thermal power plants; and the Tennessee River and its tributaries in the southeastern U.S., noted for warm-water game fish and heavily developed for both hydro and thermal power. The potential for a significant biological cost at these operating sites has been uncommonly great because of the high temperatures of the effluents, the quantities of heat discharged, and the kinds of fish at risk. The studies embrace all the obvious ways that heat might directly affect anadromous fish, including upstream migration, spawning, egg development, growth and survival, downstream migration, entrainment of plankton, food organisms, and disease. Some laboratory and field experiments suggest that a very small percentage of the river fish may at times encounter unmixed effluent that could prove lethal and that entrainment can briefly depress the abundance of zooplankton. Of much greater significance is that none of the field studies has thus far detected any heat-caused degradation of the stocks of desired fish nor significant alteration of the quality of the ecosystems except in the immediate vicinity of the dis-

charges. Effects, if any, are of a much lower order than those produced by other factors that influence the abundance of fish and other aquatic life. 23 references. (auth)

39182 (A/CONF.49/P-87) ENVIRONMENTAL EXPERIENCE WITH RADIOACTIVE EFFLUENTS FROM OPERATING NUCLEAR POWER PLANTS. Kahn, B.; Shleien, B.; Weaver, C. (Environmental Protection Agency, Cincinnati, Ohio). Sep 1971. 17p. (CONF-710901-41). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radiological surveillance activities at the eight nuclear power stations and the nuclear-fuel reprocessing plant under routine commercial operation in the U.S. are described, and current results are summarized. At each facility the operator or his contractor monitors the environment and presents findings in periodic reports to the USAEC. The appropriate state agency for public health or environmental protection also performs radiological measurements in the neighborhood of the plant, usually as part of a statewide monitoring program. The USAEC sponsors a program of independent measurements at several stations and periodic aerial radiation surveillance of the environment. New York University and the Essex Marine Laboratory are evaluating possible thermal and radiological effects of liquid effluents from two of these plants on aquatic life in the Hudson and Connecticut rivers, respectively. Studies to develop environmental surveillance guidelines have been conducted at operating facilities since 1967 by the Division of Environmental Radiation (formerly of the Public Health Service, Bureau of Radiological Health). The field studies, which were initially undertaken at a fuel reprocessing plant, a boiling-water reactor, and a pressurized-water reactor that had been in operation for several years, have now been extended to include the newer and larger light-water nuclear power stations. Concurrent measurements of individual radionuclides are made within the station, at points of waste discharge, in the immediate environment, and at points of possible human exposure. Thus the magnitude of the source, the importance of paths to and through the environment, and the extent of radionuclide dispersion or concentration are indicated. Specific procedures have been suggested for collecting appropriate samples and measuring radiation and radionuclide concentrations in environmental media at the usual extremely low levels. The major observations have been the feasibility, given sufficiently sensitive techniques, of measuring directly the critical radiation exposure pathway and the desirability of basing environmental surveillance programs on release rates of individual radionuclides measured at the source. 23 references. (auth)

39183 (CONF-710416–, Paper 19) ENVIRONMENTAL ASPECTS OF NUCLEAR POWER: SOME POINTS AT ISSUE. DiNunno, Joseph J. (Office of Environmental Affairs (AEC), Washington, D. C.). 31p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

The electric power requirements in the U. S. and the development of nuclear power plants are discussed concerning the effects on the environment. Information concerning radioactive and thermal discharges from power reactors is presented. (24 references) (D.C.C.)

39184 (CONF-710416–, Paper 20) NUCLEAR POWER FANTASY: PROBLEMS ASSOCIATED WITH THE DISSEMINATION OF NUCLEAR POWER INFORMATION. Costagliola, F. (General Physics Corp., Ellicott City, Md.). 8p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

39185 (DOCKET-50010–88) DRESDEN NUCLEAR POWER STATION, UNIT 1. Technical Information for Amendment to Technical Specifications. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 10 Jan 1961. 57p. (GEAP-3586). Dep. NTIS.

For Commonwealth Edison Co., Chicago, Ill.

Installation and operations aspects of Dresden Power Reactor Unit 1 Core 2 are described. Design parameters and system dynamics of the new fuel and core are presented. Safety analysis for Core 2 is included. (D.C.C.)

39186 (DOCKET-50219–136) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 65, Suppl. 2. (Jersey Central Power and Light Co., Morristown, N. J.). 4 Jun 1971. 6p. Dep. NTIS.

Analyses are presented to support a request for plant operation at an intermediate power level increase prior to the installation of one reactor coolant system relief valve. (H.D.R.)

39187 (DOCKET-50237–178) DRESDEN NUCLEAR POWER STATION, UNIT 2. Change No. 11 to Technical Specifications of Provisional Operating License No. DPR-19. (Division of Reactor Licensing (AEC), Washington, D. C.). 14 Jun 1971. 13p. Dep. NTIS.

The technical specifications are changed to add a scram function during startup/hot standby operation and to add a scram function in the event of piping failure in the electro-hydraulic control system for the turbine-generator. (H.D.R.)

39188 (DOCKET-50245–73) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 4 Apr 1966. 105p. Dep. NTIS.

39189 (DOCKET-50245–83) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrences No. A0-71-11 and No. A0-71-12. (Millstone Point Co., Hartford, Conn.). 4 Jun 1971. 2p. Dep. NTIS

The failure on May 25, 1971, of a valve positioner on a feedwater regulation valve and the failure on May 27, 1971, of the electric pressure regulator for the turbine control valves are reported. (H.D.R.)

39190 (DOCKET-50249–74) DRESDEN NUCLEAR POWER STATION, UNIT 3. Change No. 4 to Technical Specifications of Facility Operating License No. DPR-25. (Division of Reactor Licensing (AEC), Washington, D. C.). 15 Jun 1971. 9p. Dep. NTIS.

The Technical Specifications are amended to provide provisions to assure that the pump discharge lines of the core cooling system are maintained full of water, assure the long-term cooling capability of the core spray system, and include containment isolation valves in the drywell pneumatic supply system. (H.D.R.)

39191 (DOCKET-50250–45) TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4. Provisional Construction Permits Nos. CPPR-27 and CPPR-28, Amendment No. 1. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Mar 1969. 10p. (DOCKET-50251–41). Dep. NTIS.

The provisional construction permits are amended to eliminate the condition imposed on the adequacy of the exclusion area. (H.D.R.)

39192 (DOCKET-50267–31) FORT ST. VRAIN NUCLEAR GENERATING STATION, UNIT 1. Draft Detailed Statement on the Environmental Considerations. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). 7 Jun 1971. 34p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

39193 (DOCKET-50271–54) VERMONT YANKEE NUCLEAR POWER STATION. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 14 Jun 1971. 109p. Dep. NTIS.

39194 (DOCKET-50309–37) MAINE YANKEE ATOMIC POWER STATION. Preliminary Safety Analysis Report, Amendment 26. (Maine Yankee Atomic Power Co., Westboro, Mass.). 11 Jun 1971. 23p. Dep. NTIS.

Revised and additional information is presented concerning design parameters and operations aspects of the Maine Yankee Power Reactor. (D.C.C.)

39195 (DOCKET-50333–23) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Amended Application for Licenses (Includes Annual Report, 1970). (Power Authority of the State of New York). 4 Jun 1971. 65p. Dep. NTIS.

Financial data on the owners of the James A. Fitzpatrick Power Reactor are presented in support of the application for construction permit and operating license. The 1970 Annual Report for the Power Authority of the State of New York is included. (D.C.C.)

39196 (DOCKET-50333–24) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Amended Application for License (Includes Final Safety Analysis Report, Vol. 1). (Power Authority of the State of New York). 4 Jun 1971. 456p. Dep. NTIS.

Information on James A. Fitzpatrick Power Reactor is presented under the broad topics of site and reactor. (D.C.C.)

39197 (DOCKET-50333–25) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Amended Application for License (In-

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cludes Final Safety Analysis Report, Vol. 2). (Power Authority of the State of New York). 4 Jun 1971. 379p. Dep. NTIS.

Information on James A. Fitzpatrick Power Reactor is presented under the following broad topics: reactor coolant system; containment system; and emergency core cooling systems. (D.C.C.)

39198 (DOCKET-50333-26) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Amended Application for License (Includes Final Safety Analysis Report, Vol. 3). (Power Authority of the State of New York). 4 Jun 1971. 549p. Dep. NTIS.

Information on James A. Fitzpatrick Power Reactor is presented under the following broad topics: control and instrumentation; and electrical systems. (D.C.C.)

39199 (DOCKET-50333-27) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Amended Application for License (Includes Final Safety Analysis Report, Vol. 4). (Power Authority of the State of New York). 4 Jun 1971. 392p. Dep. NTIS.

Information on James A. Fitzpatrick Power Reactor is presented under the following broad topics: auxiliary systems; steam and power conversion system; radiation protection and radioactive waste; structures; and conduct of operations. (D.C.C.)

39200 (DOCKET-50333-28) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Amended Application for License (Includes Final Safety Analysis Report, Vol. 5). (Power Authority of the State of New York). 4 Jun 1971. 600p. Dep. NTIS.

Information on James A. Fitzpatrick Power Reactor is presented under the following headings: safety analyses; study of small fault in vicinity of discharge tunnel; circulating water systems; lake current and temperature surveys during 1969 and 1970; steam supply system component structural loading criteria and design; quality assurance program; research and development; inservice inspection program; and pressure integrity of piping and equipment pressure parts. (D.C.C.)

39201 (DOCKET-50361-18) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Amendment 10. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 16 Jun 1971. 300p. (DOCKET-50362-18). Dep. NTIS.

Revised design parameters of the San Onofre Power Reactor Units 2 and 3 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

39202 (DOCKET-50366-10) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 4. (Georgia Power Co., Atlanta). 9 Jun 1971. 71p. Dep. NTIS.

Revised design parameters of the Edwin I. Hatch Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

39203 (DOCKET-50368-12) ARKANSAS NUCLEAR ONE, UNIT 2. Preliminary Safety Analysis Report, Amendment 7. (Arkansas Power and Light Co., Little Rock). 15 Jun 1971. 22p. Dep. NTIS.

Revised design parameters of the Arkansas Nuclear One Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

39204 (LIB/Trans-357) LOSS AND DAMAGE IN NUCLEAR POWER PLANTS: AN INITIAL ANALYSIS BY INSURANCE UNDERWRITERS. Feldmann, J. (Allianz Versicherungs A. G., Munich (West Germany)). Translated by I. A. Mumme (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from report NP-18160. 33p. Dep. NTIS (U. S. Sales Only).

Operations histories of power reactors around the world are characterized by reactor type and according to systems failures such as cooling system and pressure vessel, turbines, and whole plant. Property damage caused by failures of fuel and control rods, pressure vessel, heat exchangers, and pumps and valves is discussed; severity of damage is shown graphically. Failure with causes and results are tabulated for: Agesta, Berkeley, Big Rock Point, BONUS, BR-5, Bradwell, Calder Hall, CANDU, Chapelcross, CVTR, Dounreay, EDF-1, EDF-2, EDF-3, EL-4, Elk River, Fermi Fast Breeder, Trino, G-1, G-2, G-3, Garigliano, Hallam, Hinkley Point, Humboldt Bay, Indian Point-1, Tokai Mura, JPDR, Kahl, KRB, Latina, MZFR, NPD, Oldbury, Pathfinder, Peach Bottom-1, Piqua, San Onofre, SENA, Trawsfynydd, and Yankee. A method for calculating systems reliability is described. The method is based on a statistical evaluation of mean-time-between-failure data. Expressions for single-accident probability calculations are given; matrices are constructed for system components. (72 references) (M.L.S.)

Power Reactor Development

Refer also to abstracts 37826, 37982, and 37995.

39205 (A/CONF.49/P-33) GLOBAL EFFECTS OF INCREASED USE OF ENERGY. Weinberg, Alvin M.; Hammond, R. Philip (Oak Ridge National Lab., Tenn.). Sep 1971. 9p. (CONF-710901-32). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Global limits to man's use of energy are described. These limits are set by the amount of fuel and other necessary raw materials recoverable from the earth and by the environmental side effects of the production of energy. There is essentially no limit to the amount of nuclear fuel in the earth's crust or in the seas, provided successful nuclear breeders or fusion reactors are developed. The environmental side effects include global heating of the earth; local heating near power plants; residual radioactivity; and accumulation of wastes from mining low-grade rocks for nuclear fuel. If one assumes that man's total energy generation eventually will increase 100-fold to a rate of 400 billion kilowatts, then the average increase in the earth's temperature is 0.25°C. More-accurate calculations based on a model of the atmosphere suggest that local temperatures of the landmass will exceed this average. Local heating is probably a much more difficult matter than is global heating. Possibilities for dissipating heat from large nuclear plants to the oceans appear attractive. If the budget of 400 billion kilowatts of heat is supplied by fission, the total accumulated radioactivity in the wastes would amount to more than 30 million megacuries, not counting the contribution of the very long-lived ^{99}Tc. Disposal of this radioactivity in salt appears feasible. The radioactive effluent therefore does not appear to limit practically the amount of energy man can generate on earth. The main conclusion is that man can generate energy at a much greater rate than at present without causing unacceptable changes in the environment and without exhausting fuel resources for a very long time. 8 references. (auth)

39206 (A/CONF.49/P-34) UNITED STATES LIGHT WATER REACTORS: PRESENT STATUS AND FUTURE PROSPECTS. Davis, W. Kenneth (Bechtel Corp., San Francisco, Calif.); Reinker, Paul H.; Lazar, Alan H. (Babcock and Wilcox Co., Barberton, Ohio); Sandberg, Ray O. (Bechtel Corp., San Francisco, Calif.); Winterson, Howard M.; West, John M. (Combustion Engineering, Inc., Chattanooga, Tenn.); Schubert, A. Eugene; McNelly, Malcom J. (General Electric Co., San Jose, Calif.); Rengel, Joseph C.; Stiefel, John T. (Westinghouse Electric Corp., Pittsburgh, Pa.). Sep 1971. 23p. (CONF-710901-46). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The light-water reactor (boiling and pressurized) has emerged as the predominant central-station reactor in the U.S.A. In addition, the light-water reactor is becoming the most widely used type of power reactor in the rest of the world. The reasons for this broad acceptance by operating utilities which include design and operating simplicity, compactness and low cost, an economical fuel cycle, and demonstrated reliability and safety are discussed. The development and demonstration of the key technical features are summarized, including the evolution of performance characteristics for the boiling-water and pressurized-water versions. Basic physics and engineering data are presented for the various sizes and types of light-water reactors now operating or under construction. Pertinent fuel and fuel-cycle data are included. The improvements in performance characteristics and features expected to result during the next 5 to 10 years from continuing development work are presented. The factors affecting increases in maximum unit sizes are considered, and potential increases are projected. Also discussed are the main safety systems and their evolution, along with projected developments in radioactive-waste systems, the control of radioactive gas discharges, etc. A discussion is presented of the manufacturing and construction techniques, procedures, and codes which are utilized to ensure high, uniform quality of all plant aspects and to meet USAEC licensing requirements and which result in unusually high operating reliability. Schedules for design, construction, and start-up are presented showing schedules achieved for early units, the effects of various factors on current schedules, and the schedules attainable on a normal basis. Some of the unique construction techniques involved in large plants are presented. The place of the light-water reactor in an expanding mix of thermal- and breeder-reactor power plants is presented showing that additional thermal-reactor plants will continue to be built for a long period after breeders are introduced. The associated requirements for uranium and enrichment capacity are shown to be compatible with reasonably anticipated resources. (auth)

39207 (A/CONF.49/P-44) DEVELOPMENT AND TESTING OF SODIUM COMPONENTS. Dieckamp, H. (Atomics International, Canoga Park, Calif.); Wolfe, B. (WADCO Corp., Richland, Wash.); Dickinson, R. W. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). Sep 1971. 15p. (CONF-710901-34). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The development of sodium components, pumps, valves, heat exchangers, steam generators, and fuel-handling systems for large economic liquid-metal fast breeder reactors (LMFBR's) will progress through a number of stages. Topics reviewed are: (1) the status of major sodium component experience in the U.S.A.; (2) the component requirements for large commercial LMFBR's; (3) the major technical problems, the required test information, and the expected development approach; (4) the development and test program for FFTF components and its contribution to demonstration-plant and commercial LMFBR's; and (5) the available and projected sodium component test facilities. (auth)

39208 (A/CONF.49/P-45) STATUS AND EXPERIMENTAL PROGRESS IN THE LMFBR PROGRAM. Kintner, E. E. (Division of Reactor Development and Technology (AEC), Washington, D. C.); Laney, R. V. (Argonne National Lab., Ill.); Esselman, W. H. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1971. 16p. (CONF-710901-5). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The development of the liquid-metal-cooled fast breeder reactor (LMFBR) has been given the highest priority in the U. S. reactor development program. The national LMFBR development program contains three major overlapping phases: research and development, conducted principally in the national laboratories, to provide a sound technological base in materials, physics, and safety; engineering and testing, conducted with industry, to design, manufacture, and proof-test prototypes of the fuel elements and reactor and plant components; and application, to provide practical design, construction, and operating experience from which commercial operations can proceed with confidence and to develop simultaneously an experienced and competitive manufacturing industry by building and operating several demonstration plants of commercial size. The LMFBR development programs are discussed, and the vital role of the Fast Flux Test Facility (FFTF) in this program is explained. The FFTF, now in detailed design and construction, is a unique and flexible reactor plant capable of intense fast flux irradiation of fuels and structural materials. The schedules and the content of the development work in the LMFBR program, to the maximum practicable extent, are being established to support FFTF design requirements. Thus the FFTF, by its schedular deadlines and its demands for advanced design technology similar to that of commercial LMFBR's, is serving to provide pace and relevance to most of the elements of the LMFBR development program. In a like manner, as the program proceeds plans are being developed for the first demonstration plant to take over this role from the FFTF as the focal point of the program. The status, important unanswered technical questions, and plans for future work in each phase are described. Contributions being made by the major experimental facilities, especially the Experimental Breeder Reactor No. II, the Zero Power Plutonium Reactors, and facilities at the Liquid Metal Engineering Center and the Hanford Engineering Development Laboratory are presented. 9 references. (auth)

39209 (A/CONF.49/P-48) ADVANCES IN THE DEVELOPMENT OF MOLTEN-SALT BREEDER REACTORS. Rosenthal, M. W.; Bettis, E. S.; Briggs, R. B.; Grimes, W. R.; Haubenreich, P. N.; McCoy, H. E.; McNeese, L. E. (Oak Ridge National Lab., Tenn.). Sep 1971. 12p. (CONF-710901-7). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Although development of molten-salt reactors started more than twenty years ago, the decisive test of their usability for power generation began in 1965 when the 7.3-MW(t) Molten Salt Reactor Experiment was made critical. Until shut down in December 1969, the MSRE operated reliably at 650°C, xenon was removed continuously, nuclear and chemical stabilities were demonstrated, and Hastelloy-N corrosion was <0.02 mm. In 1968, following a 6-month run, the original ^{235}U was recovered on-site by fluoride volatility, and the reactor was refueled with ^{233}U. Later plutonium was used for makeup. With the MSRE successfully demonstrating operability, attention turned to development of the technology needed for large molten-salt breeder reactors. Discovery of a reductive-extraction process by which protactinium can be transferred from fuel salt to molten bismuth and thus be kept out of the neutron flux made possible the concept of a breeder that uses a single salt containing both thorium and uranium. Later, development of the "metal transfer process" for rare-earth removal completed the processing cycle. Another achievement was enhancement of the radiation resistance of Hastelloy-N by small additions of Ti, Hf, and Nb. The effects of radiation on graphite were investigated at neutron fluences well beyond all previous experience, and a commercially available graphite was found with acceptable dimensional stability out to 3×10^{22} nvt. On the basis of these developments, a conceptual design for a 1000-MW(e) molten-salt breeder reactor was prepared. The design features are: $^{7}LiF-BeF_2-ThF_4-^{233}UF_4$ fuel salt; unclad graphite moderator; 10-day processing cycle; 4-yr graphite replacement cycle; and 540°C supercritical steam system. A unique feature is undermoderation of the outer-core region to make it serve as a breeder blanket. With this design the breeding ratio is 1.06, the total fissile inventory is 1500 kg, and the thermal efficiency is 44%. Low fuel-cycle cost can be obtained with start-up on ^{233}U, ^{235}U, or plutonium. 4 references. (auth)

39210 (A/CONF.49/P-49) U. S. CIVILIAN POWER REACTOR DEVELOPMENT PROGRAM. Shaw, Milton (Division of Reactor Development and Technology (AEC), Washington, D. C.). Sep 1971. 18p. (CONF-710901-48). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Projects now under development which form the base for the U. S. Advanced Reactors Development Program including the liquid-metal fast breeder reactor, the high-temperature gas-cooled reactor, the light-water breeder reactor, the molten-salt breeder reactor, and the gas-cooled fast breeder reactor are discussed. Also discussed are the three phases of the U. S. reactor development program: (1) the base research and development program, which includes the design and construction and/or operation of extensive facilities, such as fuels and materials irradiation test facilities, (2) the program to complete demonstration of plants of prototypical size on a programmed time scale, and (3) the introduction of commercial power plants of greater than 1000 MW(e) into the utility environmental over an indefinite period beginning in the late 1970's. (auth)

39211 (A/CONF.49/P-67) FUNDAMENTAL BEHAVIOR OF STRUCTURAL MATERIALS IN FAST REACTOR ENVIRONMENTS. Claudson, T. T. (WADCO Corp., Richland, Wash.); Sinclair, E. E. (Atomic Energy Commission, Washington, D. C.); Frost, B. R. T. (Argonne National Lab., Ill.); Boltax, A. (Westinghouse Electric Corp., Pittsburgh, Pa.); Pearlman, H. (Atomics International, Canoga Park, Calif.); Spalaris, C. N. (General Electric Co., San Jose, Calif.); Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.). Sep 1971. 17p. (CONF-710901-39). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The successful design and operation of a liquid-metal fast breeder reactor as an economical power plant depends greatly upon the development of nuclear materials technology. A survey is presented of the present knowledge of the behavior of structural and cladding materials in a fast-neutron-flux environment including radiation-induced embrittlement, swelling, radiation and thermally induced creep, and radiation-induced changes in the microstructure. The most recent findings on the effects of fast-neutron irradiation on the mechanical properties and high-temperature embrittlement of austenitic stainless steels irradiated to fluence levels of $\sim 1.3 \times 10^{23}$ nvt (E > 0.1 MeV) at temperatures of 360 to 470°C are summarized. Additional results are presented for specimens irradiated to lower fluence levels but at temperatures to 650°C, as well as a comparison of the mechanical-property behavior of Incoloy 800, 304, 316, and 347 austenitic alloys. Austenitic and ferritic steels, nickel, and special alloys were injected with helium and tested under tensile and stress rupture conditions. The results confirm that the probable mechanism of high-temperature embrittlement, as first reported in neutron-irradiated materials, is the formation of helium bubbles at the grain boundaries. Structural and compositional changes are shown to affect metal swelling and high-temperature embrittlement. A summary of experiments is presented, and theoretical and empirical analyses of radiation-induced swelling and creep are discussed. The parameters discussed include flux, fluence, temperature, stress, and metallurgical condition. The results of these analyses are presented in a form that explains the mechanisms involved and provides guidance to the designer of fast-reactor in-core components. Positive-ion bombardment (protons and heavy ions) provides a useful means of simulating fast-neutron damage in reactor structural and cladding materials. Results of studies described deal with the effect of gas concentration (helium) and displacement damage on metal swelling, the nucleation and growth kinetics of metal swelling, and radiation-induced creep. The overall integration of mechanical-property changes, microstructural changes,

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swelling, and radiation and thermally induced creep provides a basis for evaluating the behavior and performance of fuel pins, ducts, and other in-core components irradiated in a fast-neutron flux. Such a basis also provides the designer with information necessary to select a component or system concept and to establish the design of an adequate, safe, and well-performing system. 48 references. (auth)

39212 (A/CONF.49/P-102) ROLE OF INTERNATIONAL COOPERATION IN PROMOTING THE DEVELOPMENT OF THE PEACEFUL USES OF NUCLEAR ENERGY. Kratzer, Myron B. (Atomic Energy Commission, Washington, D. C.); Brunenkant, Edward J. (Division of Technical Information (AEC), Washington, D. C.); Lilley, Tom (Export-Import Bank of the United States, Washington, D. C.). Sep 1971. 29p. (CONF-710901-58). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

International cooperation in the peaceful uses of the atom has been developing since 1953 under the Atoms for Peace Program. The manner in which the technically advanced countries have shared nuclear technology and information among themselves and with the developing countries has been unprecedented. International arrangements have been a crucial factor in the exchange of technical and scientific information, supply of nuclear material and equipment, and financing of power plants. The U. S. role in these international arrangements is described. (auth)

39213 (CONF-710416-, Paper 1) AEC REQUIREMENTS CONCERNING PERSONNEL QUALIFICATIONS. Thompson, Dudley; Skovholt, Donald J. (Division of Reactor Licensing (AEC), Washington, D. C.). 5p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

39214 (CONF-710416-, Paper 3) AEC EXAMINATION RESULTS. Collins, Paul F. (Division of Reactor Licensing (AEC), Washington, D. C.). 26p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

Results of AEC reactor operator license examinations are presented. Comparisons are made of license applicants by training, education, age, and experience. (D.C.C.)

39215 (CONF-710416-, Paper 4) OBSERVED DEFICIENCIES IN TRAINING PROGRAMS. Burt, P. Allister (Niagara Mohawk Power Corp., Syracuse, N. Y.). 8p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

Possible improvements in training programs for U. S. power reactor personnel are suggested. (D.C.C.)

39216 (CONF-710416-, Paper 5) ANS 3.1 QUALIFICATION STANDARD. Reed, Glenn A. (Wisconsin Michigan Power Co., Appleton, Wis.). 22p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

A proposed standard for the selection and training of personnel for U. S. power reactors is presented. (D.C.C.)

39217 (CONF-710416-, Paper 6) PERSONNEL SELECTION FOR STAFFING A NUCLEAR POWER STATION. Barton, Paul H. (Duke Power Co., Charlotte, N. C.). 14p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

A program is outlined for selecting the personnel to staff a large nuclear power station. The objective of the program is to provide competent supervisors, AEC licensed operators available for startup, as well as adequate technical support and maintenance personnel capable of performing specialized work. (D.C.C.)

39218 (CONF-710416-, Paper 7) ROLE OF UNIVERSITIES IN TRAINING NUCLEAR FACILITY PERSONNEL. Penkala, John L. (Pennsylvania State Univ., University Park. Dept. of Nuclear Engineering). 10p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

39219 (CONF-710416-, Paper 9) TRAINING OF NDT INSPECTORS FOR COMPLIANCE WITH NUCLEAR STANDARDS. McGuffey, J. R. (Oak Ridge National Lab., Tenn.). 11p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

The ASME Boiler and Pressure Vessel Code requires that all manufacturers of pressure boundary components for nuclear systems must have a quality assurance program. Included in this requirement is a section dealing with the training of personnel for nondestructive testing of the welds. This training program, American Society for Nondestructive Testing Recommended Practice No. SNT-TC-1A, is described. (H.D.R.)

39220 (CONF-710416-, Paper 10) THREE PART 36-WEEK TRAINING PROGRAM FOR NUCLEAR FACILITY HEALTH PHYSICISTS. Hart, J. C. (Oak Ridge National Lab., Tenn.). 5p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

39221 (CONF-710416-, Paper 11) SIMULATOR EXPERIENCE BY UTILITIES. Counsil, W. G. (Millstone Point Co., Wethersfield, Conn.). 21p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

The aspects of training power reactor operators with reactor simulators are described. The simulator experience in training operators for the Millstone Point Power Reactor Unit 1 is reviewed. Advantages and disadvantages of the methods used in simulator training are analyzed. The selection of personnel for simulator instructors is discussed. (D.C.C.)

39222 (CONF-710416-, Paper 12) ON THE JOB TRAINING. Kovacs, S. J. (Philadelphia Electric Co., Pa.). 34p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

Suggested on-the-job training techniques for power reactor operators are presented. (D.C.C.)

39223 (CONF-710416-, Paper 14) ACADEMIC AND LABORATORY COURSES FOR NUCLEAR POWER PLANT PERSONNEL. Deutsch, Robert W. (Catholic Univ. of America, Washington, D. C. Dept. of Nuclear Science and Engineering). 11p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

39224 (CONF-710416-, Paper 15) STAFF PLANNING FOR NUCLEAR PROJECTS. Duvall, F. C. (NUS Corp., Rockville, Md.). 21p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

The selection of personnel by U. S. utility companies to design, construct, and operate power reactors is discussed. Nuclear power plant construction schedules and personnel training schedules are presented. (D.C.C.)

39225 (KFK-1370) REPORT ON THE RESEARCH AND DEVELOPMENT WORK CARRIED OUT IN THE KARLSRUHE NUCLEAR RESEARCH CENTER ON THE STEAM-COOLED FAST BREEDER. Engelmann, P.; Erbacher, F.; Karsten, G.; Ritz, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Dec 1970. 167p. (In German). Dep. NTIS (U. S. Sales Only).

Work conducted on the steam-cooled fast breeder reactor within the Fast Breeder Project from 1961 until 1970 is reviewed. In addition to a detailed documentation and a summary of individual results obtained at the Karlsruhe Nuclear Research Center, work performed by industry is described. Based on the results described and by comparison with the situation encountered in the development of fast breeders with sodium and helium cooling, an evaluation of the situation is given and recommendations are provided for future action. (auth)

39226 (NP-18809) ANNUAL SCIENTIFIC REPORT, 1969. Billiau, R.; Buyse, L.; De Coster, M.; Fredrix, H. (eds.) (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 222p. (D-69/70). Dep. NTIS (U. S. Sales Only).

Information concerning laboratory activities during 1969 is presented under the following main headings: development of fast reactors; development of thermal reactors; basic and exploratory research; safety studies; production and application of radioisotopes; actinium program; the BRZ reactor and associated facilities; scientific support; and technical support. Separate abstracts are presented for 6 of the 9 chapters included. (D.C.C.)

For abstracts of individual chapters see: 37542, 37543, 37562, 39227, 39228, and 39309.

39227 (NP-18809, pp 1.1-33) DEVELOPMENT OF FAST REACTORS. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

In Annual scientific report, 1969.

The development of mixed oxide fuel was continued with regard to flowing and sintering properties of the mixed oxides, recycling of fabrication scraps and production of low density pellets. Long term irradiations were performed in capsules, up to a maximum burn-up of 45,000 MWd/t, and in a sodium loop of the BR2 reactor. The contribution to the basic reactor physics program consisted mainly in the improvement of basic nuclear data by integral and differential measurements and in development of reactor codes. Multigroup cross-section libraries were produced as input data for reactor core calculations. The practical conditions for the preparation of UC are now fully controlled and understood, also with regard to stabilization by addition of vanadium carbide or the inclusion of a U_2C_3 phase. The problem of compatibility with the canning materials also seems to be under control. The development of dispersion strengthened ferritic alloys was continued. The alloy Fe 13 Cr 2 Mo 5 Ti containing 4 vol. % TiO_2 shows at 700°C similar mechanical properties as the commercial austenitic alloys. Irradiation up to 2.7×10^{21} nvt shows that the ferritic structure is less affected by irradiation than the austenitic structure. In addition to the existing types of in-pile loops and capsules in BR2, the design and construction of the following devices were started: an in-pile sodium-cooled loop with a total heat dissipation capacity of 500 kW; CIRCE capsules for the irradiation of UC and mixed carbide in thermal flux; and various extrapolations of the liquid metal filled FAFNIR rig, with uprated heat dissipation capacity and more elaborate instrumentation. The results obtained in fluoride volatility fuel reprocessing indicate that important problems, such as reaction kinetics and temperature, Pu losses and handling of PuF_6 can be controlled. (auth)

39228 (NP-18809, pp 2.1-14) DEVELOPMENT OF THERMAL REACTORS. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

In Annual scientific report, 1969.

Development work in the field of thermal reactors was carried out essentially in three areas leading to short term conclusions in the field of core study and fuel fabrication. Included were: (1) Operation of the BR 3/Core 2 bis which was first made critical on July 9; (2) Fuel cycle evaluation and the continuation of a series of critical experiments in the VENUS facility in view of recycling plutonium in thermal reactors; and (3) Development of fabrication techniques for plutonium containing fuel, both by pelletizing and by vibrocompacting heterogeneous powders; the fuel was tested under extreme conditions through irradiation experiments in BR 2. In addition, two smaller programs were devoted to preparing and carrying out irradiation experiments on burnable poisons in a homogeneous mixture with fuel material and the development of coated fuel particles for high temperature gas reactors. On this occasion, original techniques were developed for the fabrication of pellets without addition of binders or lubricants to the fuel. (auth)

39229 (ORNL-4541) CONCEPTUAL DESIGN STUDY OF A SINGLE-FLUID MOLTEN-SALT BREEDER REACTOR. Robertson, Roy C. (comp.) (Oak Ridge National Lab., Tenn.). Jun 1971. Contract W-7405-eng-26. 207p. Dep. NTIS.

Design calculations and parameters for a reference 1000 MW(e) single-fluid molten-salt reactor are presented under the following broad topics: overall systems descriptions and features; reactor primary system; coolant-salt circulating system; steam-power system; fuel-salt drain system; reactor off-gas system; fuel-salt processing system; liquid waste disposal system; plant operation, control, and instrumentation; auxiliary systems; maintenance and repair systems; buildings and containment; site description; cost estimates for MSBR station; and uncertainties and alternatives, and their effects on feasibility and performance. (129 references) (D.C.C.)

39230 DETECTION OF DEFECTIVE FUEL ELEMENTS IN WATER-COOLED REACTORS. Simanova, Ruzena (Inst. of Nuclear Research, Prague). Jad. Energ.; 17: No. 3, 87-97 (1971). (In Czech).

A review of the methods of detection of cladding defects of water-cooled reactor fuel elements is presented. These methods fall into two groups depending upon whether (1) fission products are detectable immediately in the heat transfer medium, or (2) detection is possible only after the fission products have been deposited from water. The first group involves the detection of delayed neutrons, high energy beta radiation by means of Cherenkov detectors, and gamma radiation (after lowering the background level by means of ion exchangers). The second group is concerned with detection of the beta and gamma emitting gaseous fission products Kr and Xe and their daughters Rb and Cs with the aid of electrostatic precipitators. 23 references. (tr-auth)

39231 PRESSURE VESSEL CODES: THEIR APPLICATION TO NUCLEAR REACTOR SYSTEMS. FINDINGS FROM A SURVEY BY THE INTERNATIONAL ATOMIC ENERGY AGENCY. Technical Reports Series No. 56, 1966. Vienna; International Atomic Energy Agency (1966). 25p. Available from International Atomic Energy Agency, Vienna.

The replies of 15 member states to an inquiry concerning the problems of applying national pressure vessel codes to nuclear reactors are presented. Included in the discussion are regulatory aspects of codes, scope and content of national codes, code applications, nuclear codes, and special requirements of codes for application to nuclear vessels. 21 references. (H.D.R.)

39232 FAST REACTOR ASSESSMENT STUDY. Ekholm, Reino (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Technol.; 10: No. 3, 249-56(Mar 1971).

An assessment of the relative merits of helium, sodium, and steam cooled fast breeders was completed in Sweden in 1969. Breeders have the potential of reducing overall system power costs provided no more than 40 million tons of uranium can be mined below \$15/lb U_3O_8. The breeders—particularly those cooled by Na or He—set reasonable upper limits to mining and enrichment capacity requirements. The difficulties in developing the fuel are the outstanding problems for these breeders, and are relatively hardest for the steam cooled type. Steam cooling shows the lowest capital costs, followed by helium cooling, and is relatively promising with low-cost uranium. Sodium cooling involves the most extensive research and development program, while the helium or steam cooled breeders are largely based on thermal reactor technology and offer real potential as advanced next generation plants. However, the uncertainties even of the relative assessments still overlap the estimated power cost differences of 0.4 mill/kWh. (auth)

Kinetics and Dynamics

39233 (BNWL-SA-3756) MEASUREMENT OF THE TEMPERATURE DEPENDENCE OF K_∞ FOR A $^{233}UO_2$-ThO_2 HTGR LATTICE. Lippincott, E. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1970]. 10p. (CONF-710606-2). Dep. NTIS.

From seventeenth annual meeting of the American nuclear society; Boston, Mass. (13 Jun 1971).

The second in a series of experiments using the High Temperature Lattice Test Reactor has been completed and provides information on the temperature dependence of K_∞ for a $^{233}UO_2$-$^{232}ThO_2$-C fuel mixture. The infinite medium multiplication factor was found to decrease by .0322 ± .0015 from 20°C to 1000°C. This result provides direct information necessary in the design of the control system and in the safety analysis for advanced High-Temperature Gas-Cooled reactors. (6 references) (auth)

39234 (IAEA-119, 6p.) POWER REACTOR NOISE MEASUREMENTS. Bastl, W. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116-3). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

Measurements of power reactor noise sponsored by the German government and some investigations started by industry are described. (INIS)

39235 (IAEA-119, 17p.) ON LINE ESTIMATION OF REACTOR STATES AND PARAMETERS FROM NOISE MEASUREMENTS. Hassan, M. A.; Azer, M. S.; Ghonaimy, M. A. R. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116-17). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

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Time domain sequential estimation is presented as an approach to state and parameter estimation from available noise measurements. This technique would require, in general, an on-line computer for its implementation. However, for low order systems which can be approximated by a single differential equation, analogue blocks can be used to construct the required on-line estimators. Reactivity estimation from noise period measurement is discussed as an example. (auth) (INIS)

39236 (LB/G–3027) USE OF DIAMOND AS A REFERENCE STANDARD FOR IRRADIATION CONDITIONS. Nikolaenko, V. A.; Karpukhin, V. I.; Alekseev, S. I. (Institut Atomnoi Energii, Moscow (USSR)). Translated by J. A. Bartlett (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE–1650. 17p. (CONF-691060–15). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

Arguments are presented concerning the choice of a suitable standard for recording and retaining information on the irradiation conditions for materials investigations in a nuclear reactor. It is shown that diamond is one of the best materials for this purpose. A method is described for using diamond to measure the neutron flux causing radiation damage in materials. Methods are also described for measuring the irradiation temperature using calibrated and preirradiated diamond. Experimental results are presented which show that diamond can be used simultaneously to indicate neutron flux and irradiation temperature and to record the level of γ-radiation in the reactor. (10 references) (auth)

39237 MEASUREMENT OF FLUX FINE STRUCTURE IN PLATE FAST REACTOR CELLS OF FINITE SIZE. Palmedo, Philip F.; Windsor, Henry H. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 44: No. 3, 388–97(Jun 1971).

Two types of measurements of flux fine structure were performed in simple, plate, fast reactor cells. In the first type, studies were made of the rate at which the fine structure approached equilibrium when test cells were placed in an equivalent homogeneous medium. It was shown that caution must be exercised in applying an infinite plane model to the calculation of heterogeneity effects in plate cells of finite dimensions. In the second type of measurement, detailed activation distributions were measured in a series of cells as a basis for the evaluation of cross sections and calculational models. 18 references. (auth)

39238 ANALYSIS OF FLUX FINE STRUCTURE IN ONE-DIMENSIONAL FAST REACTOR CELLS. Ludewig, Hans (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 44: No. 3, 398–405(Jun 1971).

An analysis of a previously reported heterogeneity experiment is described. The nuclear data used are based on ENDF/B Versions I and II and the DSN method is used in the analysis. In addition to determining the intracell fine structure for ^{235}U and ^{238}U fission and Mn capture, the variation of absolute $^{235}U/^{238}U$ fission ratio as a function of cell size is investigated. From these results it can be concluded that the fission ratio calculations are particularly sensitive to the fission cross section of ^{235}U and ^{238}U, suggesting that measurements of this type could be useful in checking the accuracy of data. The overall agreement between computed and measured quantities was found to be good for all quantities that could be characterized as asymptotic. The nonasymptotic nature of some quantities is investigated using two-dimensional calculations. (auth)

39239 *GENERALIZED LOCAL BOILING VOID MODEL FOR* LIGHT-WATER REACTOR SYSTEM. Sha, William T. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 44: No. 3, 291–300(Jun 1971).

A generalized model is presented for computing local void distribution, both radial and axial, in a light-water-moderated reactor channel. This model assumes that steam bubbles can be treated as free particles; thus, the continuity equation can describe the bubble motion. The model presented is considered to be particularly suitable for computer programming. It explicitly and simultaneously computes heat balance and conservation of mass, as well as void distribution. Furthermore, it provides sufficient flexibility to adjust constants in the equation so that any desired calculated void distribution can be obtained. Three existing pertinent void models constitute special cases of the proposed model. 10 references. (auth)

39240 REACTIVITY EFFECT OF REPLACING A WATER REFLECTOR WITH LEAD. Klotzkin, G.; Valentine, R. F.; Flanagan, C. A.; Stachew, J. C. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng.; 44: No. 3, 413–22(Jun 1971).

A series of experiments performed at the High Temperature Test Facility indicated that placing lead in the water-reflector region of a water-moderated thermal reactor causes the reactivity of the core to increase. Two-dimensional diffusion theory calculations of the above-mentioned experiments also predicted this, but undercalculated the $\Delta k/k$ effect of 6 in. of lead by 25%. In addition, two-dimensional diffusion theory and Monte Carlo calculations were used to analyze the reactivity effect of a lead shipping container surrounding a Seed 2 cluster from Shippingport Core 2. All the calculations revealed that the presence of lead in the reflector region of a water-moderated core causes the reactivity of the core to be significantly higher than a core with a pure-water reflector. (9 references) (auth)

Control Systems

Refer also to abstract 39260.

39241 (IAEA–119, 4p.) AEROBALL SYSTEM FOR PWR'S. Haebler, D. von (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–14). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The aeroball system for flux scanning is installed in an improved version in German PWR's. The first one in Obrigheim Power Reactor uses steel balls with specified Mn content, but replaces all ball valves and storage lines by one storage drum with 90 guide tubes. The 6 groups of 15 ball columns each can be activated within the total decay time of Mn of about one day. The measurement of column activity by means of a scintillation counter takes about $^3/_4$ of an hour for one group. (INIS)

39242 (IAEA–119, 47p.) EXPERIENCE WITH AND IDEAS ON THE INSTRUMENTATION FOR NUCLEAR POWER PLANT CONTROL. Furet, J.; Delmas, F. (International Atomic Energy Agency, Vienna (Austria)). 1970. (In French). (CONF-691116–11). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

39243 METHOD OF STABILIZATION OF THE POWER OF A LIQUID-MODERATED LIQUID-COOLED NUCLEAR REACTOR. (to Electricite de France). British Patent 1,234,914. 9 Jun 1971. Priority date 24 Dec 1968, France.

REACTOR CONTROL SYSTEMS—design characteristics of boiling reactor power stabilizing

REACTORS, BOILING—control system for, description of power stabilizing boiling moderator (D.C.C.)

39244 CAPILLARY VALVE FOR USE IN THE VENTILATION OF FAST BREEDER CONTROL RODS. Heenan, William A.; Camp, David T. (Atomic Power Development Associates, Inc., Detroit). Nucl. Technol.; 11: No. 2, 191–205(Jun 1971).

A "capillary valve" having no moving parts, suited for use in corrosive media, has been designed and developed. The valve permits the bleeding of a gas into a liquid region if a certain pressure difference is exceeded and also prevents the counterflow of liquid. The valve consists of a porous metallic disk or plug which has small-diameter interconnected pores which average between 0.1 and 5 microns and have the essential property of being wet by the liquid involved. (18 references) (auth)

Cooling Systems

Refer also to abstracts 37393, 37672, 37695, and 37931.

39245 (CONF-710512–5) DESIGN FOR IN-SERVICE INSPECTION OF BOILING WATER REACTOR PRESSURE VESSELS. Holt, R. C.; Hubbard, A. M. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 12 Feb 1971. 9p. (71-PVP–59). ASME, New York $2.00.

From first national congress on pressure vessels and piping; San Francisco, Calif. (10 May 1971).

The in-service inspection code requirements for boiling water reactor pressure vessels are described. The design objectives and design features to provide a practical continuing program which demonstrates the safety and reliability of pressure vessels are discussed. (auth)

39246 IMPROVEMENTS IN AND RELATING TO A PUMP OR FAN ARRANGEMENT, e.g. IN A NUCLEAR REACTOR. Eggmann, Jean; Sidler, Ernst (to Brown Boveri, and Co. Ltd.). British Patent 1,234,061. 3 Jun 1971. Priority date 22 Jun 1967, Switzerland.

BLOWERS—design parameters of removable, for gas cooled reactors

REACTORS, GAS-COOLED—blowers for, description of removable (D.C.C.)

39247 INTEGRATED REACTOR. Costes, Didier (to Commissariat a l'Energie Atomique). French Patent 2,036,828. 31 Dec 1970. Filed 4 Apr 1969. (In French).

The invention proposes an integrated reactor cooled by the circulation of a liquid coolant in a vessel containing a fuel core, at least one heat exchanger and at least one pump circulating the coolant between the core and the exchanger. The reactor is characterized by a slab which supports the core and transversely divides the vessel into an upper part containing the core, exchanger and pump, and a lower part in which a distributor for receiving the cold coolant from the outlet of the pump and sending it into the core and upper assembly and a collector of cold coolant at the exchanger outlet are arranged. There are vertical skirtings above the slab which connect the collector to the admission of the pump and the outlet of the exchanger. The invention includes two baffle columns above the slab in the free space left by the core and the skirtings. A means exists for circulating a fraction of the cold coolant from the distributor in the columns towards the upper end of the vessel. Thus excessive vertical temperature gradients in the principal vessel and the pump and exchanger enclosures are avoided. (auth) (France)

39248 CARBON TRANSPORT IN FLOWING SODIUM. Roy, Prodyot; Wozadlo, Gary P. (General Electric Co., Sunnyvale, Calif.). Nucl. Technol.; 10: No. 3, 307-14(Mar 1971).

In a completely austenitic stainless steel system containing flowing sodium under a temperature gradient, carbon transferred from high (1300°F) to low temperature regions (1100°F). This mode of carbon transport cannot be explained from the temperature dependence of the activity of carbon in stainless steels. Based on simple thermodynamic calculations and analysis of electron energy levels in liquid sodium, various models of mechanism and species involved in carbon transport are analyzed. A new model where atomic carbon (in solution in sodium) is responsible for the carbon transport in an austenitic stainless steel system is proposed. Furthermore, it is believed that the temperature variation of the activity of carbon in solution in sodium determines the direction of carbon movement. (30 references) (auth)

Fuels

39249 (A/CONF.49/P-77) STATUS OF ENGINEERING DESIGN AND IRRADIATION TESTING OF THE STAINLESS CLAD-MIXED OXIDE FUEL SYSTEM FOR FAST BREEDER REACTORS. Evans, E. A. (Hanford Engineering and Development Lab., Richland, Wash.); Kintner, E. E. (Division of Reactor Development and Technology (AEC), Washington, D. C.); Zebroski, E. L. (General Electric Co., Sunnyvale, Calif.); Neimark, L. A. (Argonne National Lab., Ill.); Cox, C. M. (Oak Ridge National Lab., Tenn.). Sep 1970. 16p. (CONF-710901-16). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The U. S. liquid-metal fast breeder reactor (LMFBR) program is principally focused on stainless-steel-clad PuO_2-UO_2 fuel. Engineering-design and irradiation-testing studies are surveyed. These and supporting studies are providing increased assurance that this fuel will operate safely, reliably, and economically in LMFBR systems. The main avenues of design available to extend fuel performance capabilities are through selection of pin-design parameters, coolant-channel design, and reactor operating conditions responsive to information from testing programs. Because complex relations between fuel-design parameters and fuel and cladding behavior are determinable only in fast reactors, the U. S. has emphasized a broad-based fuel-pin irradiation program in Experimental Breeder Reactor No. II (EBR-II), supplemented by thermal reactor irradiations and laboratory measurements of basic parameters (e.g., thermal conductivity as related to fuel structure). Considerable effort has also been expended in defining neutron and temperature environments. Tests of deliberately defected fuel, as well as transient tests, are exploring fuel-pin behavior and failure thresholds under off-normal conditions. Exceptionally well characterized fuel and cladding material with computerized data storage and analysis provide the bases for extension of experimental results to the fluences, burnups, and temperatures appropriate to large reactor core applications. Clad swelling and creep, clad ductility, and fuel properties are major factors in this extrapolation. Approximately 2000 mixed-oxide pins have been irradiated in EBR-II. Parameters studied include annular and solid pellets and compacted-powder fuel forms of 84 to 96% smeared density, 200 to 800 W/cm power rating, and cladding temperatures to 700°C. More than 65 instrumented mixed-oxide pins have been irradiated in fast and thermal reactors. No failures have occurred (December 1970) in unencapsulated pins irradiated to 7 to 8 at. %; encapsulated pins have reached burnups of 13 at. %. 45 references. (auth)

39250 (A/CONF.49/P-80) DEVELOPMENT OF IMPROVED LIGHT WATER REACTOR FUELS. Zinn, W. H. (Combustion Engineering, Inc., Windsor, Conn.); Bleiberg, M. H. (Nuclear Materials and Equipment Corp., Apollo, Pa.); Chernock, W. P. (Combustion Engineering, Inc., Windsor, Conn.); Ferrari, H. M. (Westinghouse Electric Corp., Pittsburgh, Pa.); Lyons, M. F. (General Electric Co., San Jose, Calif.); Stern, T. (Westinghouse Electric Corp., Pittsburgh, Pa.); Walke, G. J. (Consumers Power Co., Jackson, Mich.). Sep 1971. 17p. (CONF-710901-17). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A summary is presented of U. S. experience with light-water-reactor fuel. Performance experience has shifted from test and demonstration plants to large power reactors. This experience has been utilized to evolve designs with greater efficiency. Peak local burnups and linear heat ratings of recent designs are on the order of 50,000 MWd/t of uranium and 18.9 kW/ft for power reactors in the 800- and 1100-MW(e) class. Early commitments to stainless-steel cladding and segmented rods have given way to Zircaloy cladding and uninterrupted fuel columns. A summary of important design features of boiling-water-reactor and pressurized-water-reactor fuel rods and assemblies is provided. Properties of oxide fuel, Zircaloy cladding, and their interaction under actual power-reactor conditions are assessed. The influence of these materials properties on fuel-rod performance is discussed and compared with actual experience and predictions of performance design codes. On this basis, current power-reactor target peak burnups and linear heat ratings are reviewed. The influence of reactor power cycling on fuel-rod performance is discussed. Fuel-rod integrity in operating reactors has been very good. A review of the limited instances of defective rods is provided. Plutonium-recycle fuel concepts and in-reactor experience are discussed for both pelletized and vibratory compacted fuel forms. A summary of the current status of the light-water breeder reactor thorium cycle fuel program is presented. Finally, a projection of future fuel performance trends is made. 106 references. (auth)

39251 (A/CONF.49/P-838) ANALYTICAL METHODS TO DESIGN AND PREDICT PERFORMANCE OF FAST REACTOR FUEL ELEMENTS. Shewmon, P. G. (Argonne National Lab., Ill.); Cunningham, G. W. (Atomic Energy Commission, Washington, D. C.); Dickerman, C. E. (Argonne National Lab., Ill.); Hines, D. P. (General Electric Co., San Jose, Calif.); Homan, F. J. (Oak Ridge National Lab., Tenn.); Last, G. A. (Hanford Engineering Development Lab., Richland, Wash.); Murray, P. (Westinghouse Electric Corp., Madison, Pa.). Sep 1971. 18p. (CONF-710901-45). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The success of the liquid-metal fast breeder reactor concept is dependent on the attainment of low fuel-cycle costs and, therefore, on the satisfactory behavior of the fuel to high burnup. Over the last few years, substantial progress has been made in developing models and analytical methods to predict the performance of fuel elements. The analytical methods being developed in the U.S.A. to understand fuel-element performance are surveyed and the applications resulting from interpretations of irradiation test results are summarized. The information and models needed to develop the analysis of fuel-element behavior are presented together with an outline of the approaches adopted by the participating laboratories. The principal differences among the various codes result from the degree to which plasticity, swelling, and structural changes in the fuel are treated in arriving at the force exerted by the fuel on the cladding. Examples of the application of the codes are given. Considerable experimental data are available for the metal fuel and blanket in Experimental Breeder Reactor No. II (EBR-II), and a code has been developed that has been quite useful in providing the basis for operation at higher power and higher burnup. The analysis of mixed-oxide fuel is more complex because of stronger fuel, larger temperature gradients, complex swelling mechanism, and cracking in the fuel. Applications of the codes in the following areas are outlined: (1) Relating changes in materials properties to fuel-element performance, (2) correlating and interpreting the results of the mixed-oxide irradiation program in EBR-II, and (3) relating changes in fuel-element design and operating history to fuel-element performance. The value of this approach in the definition of the critical irradiation experiments needed to obtain the data for more accurate prediction of fuel-element performance and also in the definition of meaningful statistical irradiation programs is also described. Finally, the work being carried out to extend these models to treat transient and off-normal conditions is outlined together with a survey of the experimental results to date. 56 references. (auth)

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39252 (CEA-Bib-195) CHARACTERISTICS OF FISSION PRODUCTS PRINCIPALLY IDENTIFIED IN FAST REACTORS IN VIEW OF DETECTING BURST SLUGS. Donguy, Rene (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1971. 157p. (In French). Dep. NTIS (U. S. Sales Only).

A bibliography consisting of chronological descriptions and divided into two parts is presented. The first part covers the period from October 1963 to February 1970 and relates to various documentation presented in the form of 4 classifications (reactors, measuring methods, products detected, and publications). The second part covers the period from January 1964 to January 1970 and is solely concerned with ANL documents classified according to measuring methods and products detected. (auth) (France)

39253 (RD/B/N-1932) EFFECT OF HEAT SOURCE BOUNDARY CONDITIONS ON THE TEMPERATURE DISTRIBUTIONS IN TRANSVERSE AND HELICALLY RIBBED A.G.R. FUEL PINS. Watts, J.; Mantle, P. L. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1971. 23p. Dep. NTIS (U. S. Sales Only).

Steady state temperature distributions in the ribbed can walls of Advanced Gas-Cooled Reactor fuel element pins are investigated analytically using the computer program ORSFT2. The reactor situation is examined where all the heat is generated in the fuel which fills the can. Temperature distributions thus obtained are compared with those that would arise in the laboratory, where the cans are often heated by passing an electric current axially through the can wall. Several examples are examined for different distributions of heat generation, corresponding to those expected in transverse and helically ribbed cans. It is concluded that in the interpretation of heat transfer tests, the correction required to allow for the heat generation in the ribs is small in the case of multi-start cans, and negligible in the case of transverse ribbed cans. Data is also given for converting temperatures measured in the bore of test cans to maximum surface temperatures. (auth) (UK)

39254 IMPROVEMENTS IN CLOSING PRESSURE TUBES OF NUCLEAR REACTORS. Bonnet-Thirion, J.; Robida, L. (to Societe Babcock-Atlantique). French Patent 2,036,874. 31 Dec 1970. Filed 14 Apr 1969. (In French).

A stop valve ensuring the closure of the end of the pressure tube is proposed. This valve is designed so that it can be compressed against its sealing seat by an autoclave effect. It is characterized by the fact that in the closed position it is maintained against its seat by a spring device which compresses the fuel load in the tube. In this stop valve the force of the spring is utilized in perfecting the sealing which is assured even if the pressure inside the tube falls to zero. (auth) (France)

39255 APPARATUS FOR STUDY OF IN-PILE CREEP OF FUELS. Robinson, R. A.; Basham, S. J.; Perrin, J. S. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Technol.; 11: No. 2, 206-11(Jun 1971).

An in-pile creep measuring apparatus was developed to obtain data on the compressive creep of ceramic fuel materials during the fission process. Experiments were conducted on annular specimens of unclad UO_2 at fission rates up to 1.2×10^{13} fissions/cm^3 sec, fuel temperatures in the range 1000 to 1300°C, and stress levels of 1000 to 4000 psi. The specimens were loaded in compression by a bellows-sealed, gas-pressure-actuated piston. Specimen temperatures were controlled, both in and out-of-pile, by electrical heaters. Axial deformation of the cylindrical specimens was continuously measured by a pneumatic displacement transducer. (5 references) (auth)

39256 APPLICATION OF FUEL-ELEMENT MODELING CODES TO EBR-II DRIVER FUEL. Walter, C. M.; Shewmon, P. G.; Bacca, J. P. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Technol.; 11: No. 1, 38-44(May 1971).

A metallic fuel element modeling code (BEMOD) was developed to describe the irradiation behavior of EBR-II driver fuels. BEMOD was applied to both the Mark IA and the advanced Mark II driver fuels. Good agreement on cladding diameter changes as a function of burnup is obtained between calculations and measurements on irradiated fuel elements. The code calculations indicate that at a reactor power of 50 MW(t) the Mark IA element is capable of about 3.5 at. % before a cladding Δ D/D of 2% is expected while the Mark II design should be capable of about twice that burnup before a similar cladding Δ D/D is attained. The increase in reactor power to 62.5 MW(t) appears to have no appreciable effect on the above values. (15 references) (auth)

Auxiliary and Emergency Systems

39257 (GEAP-13172) SCALE MODEL TESTS OF FISSION-PRODUCT REMOVAL IN SUPPRESSION POOLS. Siegwarth, D. P.; Siegler, M. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr 1971. Contract W-7405-eng-26. 42p. Dep. NTIS.

A 1/10,000 scale-model of a BWR pressure-suppression containment system was designed and constructed to study the absorption of methyl iodide in suppression pools at loss-of-coolant accident conditions. The model containment system provided a reasonable simulation of the conditions expected in the event of a loss-of-coolant accident. The experimental results showed the absorption of methyl iodide in the model suppression pool was not affected by increasing the containment inventory of methyl iodide from 0.2 to 2 mg, the radial position of the downcomer in the pool (that is, no change of absorption in the model because of wall effects or possible differences in pool circulation), or changing the pH of the pool from 7 to 10. The pool absorption for a downcomer submersion depth of 1 ft was about 20% lower than for 4-ft submersion; the absorption for an initial pool temperature of 150°F was approximately 28% lower than that for 90°F. An increase in the delay time between the initiation of the blowdown and the addition of methyl iodide to the drywell initially increases the pool absorption, and then for a delay greater than about 2 seconds, the pool absorption decreases with increasing delay until the absorption at 6 seconds delay is about 24% less than that for zero delay. (10 references) (auth)

39258 (IAEA-119, 4p.) PRESENT STATUS OF HIGH TEMPERATURE RADIATION DETECTORS IN THE U. K. Goodings, A. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116-13). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

Typical test results from new detectors are given. The evidence to date indicates that particularly P7, DC12 and DC14 radiation detectors will satisfactorily withstand a temperature greater than 500°C and also the irradiation conditions expected in-core in gas-cooled and sodium-cooled power reactors for the specified three year period. It is on this basis that they had been ordered in quantity for a number of the UK power reactors. (INIS)

39259 (IAEA-119, 4p.) OPERATIONAL TEMPERATURE MEASUREMENTS INSIDE REACTOR CHANNELS: REASONS AND METHODS OF IMPLEMENTATION. Lourme, P. (International Atomic Energy Agency, Vienna (Austria)). 1970. (In French). (CONF-691116-22). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

39260 (IAEA-119, 5p.) SUMMARY OF U. K. EXPERIENCE OF INSTRUMENTATION AND CONTROL EQUIPMENT IN NUCLEAR REACTORS. Golder, J. A. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116-12). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The results of UK experience of instrumentation and control equipment on nuclear power reactors are given. Portable Health Physics monitors are a problem because they are portable and insufficiently rugged to withstand normal mishandling and therefore cause severe maintenance problems. Spare parts are often difficult to obtain because of the rapid obsolescence of this kind of equipment. (INIS)

39261 (WCAP-7486) AN EVALUATION OF ANTICIPATED OPERATIONAL TRANSIENTS IN WESTINGHOUSE PRESSURIZED WATER REACTORS. Gangloff, W. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). May 1971. 71p.

A recent development in nuclear power plant safety studies has been the categorizing of certain "anticipated" plant transients as a special class of events requiring special attention. These anticipated events are abnormal operational transients which constitute a demand for action by the reactor protection system and which are anticipated to occur sometime in the design life of the plant. A detailed failure analysis of the reactor protection system is presented considering both random component failures and systematic or common-mode failures. The Indian Point Unit 2 plant was used as a basis for the study, but results are generally applicable to the present generation of pressurized water reactor plants. Results of the failure analysis presented show that the likelihood of failure to trip the reactor in anticipated transients is so small that the occurrence can be practically considered incredible. Measures taken to minimize the likelihood of such failure are discussed in detail. Because of these results, it can reasonably be concluded that existing design measures taken in PWR plants with relay protection logic give adequate assurance that anticipated transients present no undue risk to public health and safety. Thus, no special pro-

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visions are proposed for incorporation in the design to cope with the consequences of the hypothetical cases of transients without trip. 5 references. (auth)

39262 (WCAP-7672) SOLID STATE LOGIC PROTECTION SYSTEM DESCRIPTION. Katz, D. N. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems [Div.]). Jun 1971. 59p. Dep. NTIS.

By applying solid state techniques to the design of the reactor protection and engineered safety features actuation systems, it is apparent that significant improvements can be made over previous designs utilizing relays. Designated as the Solid State Protection System, the design which includes both reactor protection and and Engineered Safety Features Actuation uses integrated circuit NAND gates as the basic logic elements. These elements are assembled on printed circuit cards to form the building blocks for the system. Although reference to four loop plants is presented, the same building blocks are used in the two and three loop plant systems even though the required logic may be somewhat different. (auth)

39263 THERMAL SHIELDING DESIGNED ESPECIALLY FOR A NUCLEAR REACTOR TANK. Schaller, Karl; Costes, Didier; Delisle, Jean-Paul; Gallo, Sabino (to Commissariat a l'Energie Atomique). French Patent 2,036,738. 31 Dec 1970. Filed 10 Mar 1969. (In French).

A device for ensuring the thermal shielding of the tank of a fast Na cooled reactor during the startup or shutdown transients is described. The upper part or roof of the tank and the lateral skirt in the part attached to the roof are surrounded by a closed gap on the inner side of the tank. The gap, enclosed by a metallic envelope parallel to the sides of the tank, is completely filled with liquid Na. The heat is transfered to the roof and the skirt by the Na; the liquid Na circulating by natural convection acts as a thermal absorber. (France)

Operation and Economics

Refer also to abstracts 39209 and 39325.

39264 (A/CONF.49/P-47) MAJOR CONTRIBUTIONS FROM EBR-II, SEFOR, AND FERMI. Levenson, M. (Argonne National Lab., Ill.); Arterburn, J. O. (General Electric Co., Sunnyvale, Calif.); Jens, W. H. (Atomic Power Development Associates, Inc., Detroit, Mich.); Alexanderson, E. L. (Power Reactor Development Co., Detroit, Mich.). Sep 1971. 15p. (CONF-710901-6). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The current U. S. fast reactor program continues to advance based upon the technology obtained from its many nuclear facilities, including the Experimental Breeder Reactor No. II (EBR-II), Southwest Experimental Fast Oxide Reactor (SEFOR), and Enrico Fermi Atomic Power Plant, each of which serves its own role. The EBR-II demonstrated the feasibility of the "pot concept design" and now is operating as a fast test reactor. The SEFOR has contributed in the safety area by providing an integral measurement of the Doppler coefficient with a core characteristic of one type of large ceramic-fueled fast breeder reactor, and the Fermi has operated as a 200 MW(t) utility-grid demonstration plant. The recent results obtained and the experience of operation of the three plants are described. 16 references. (auth)

39265 (A/CONF.49/P-60) PRICE FORECASTING AND RESOURCE UTILIZATION FOR THE FUEL CYCLE INDUSTRY OF THE UNITED STATES. Salmon, R.; Roberts, J. T.; Lotts, A. L.; Washburn, T. N. (Oak Ridge National Lab., Tenn.); McVey, W. H. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Sep 1971. 13p. (CONF-710901-36). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In 1966 the USAEC initiated a systems analysis of electrical-power generation in the U.S.A., with the main purpose of estimating the costs and benefits potentially derivable from the development of new types of nuclear reactors. Fuel-cycle-component costs were estimated on a time-dependent basis for all reactor types considered in the study. A computer code, FUELCO, was developed to simulate the growth of the fuel-cycle industry and to estimate the unit prices of fuel-cycle services as a function of time, taking into account the economics of the industry as a whole and the competition within the industry. The basis for the FUELCO code is described and typical price vs time curves obtained by applying the code to various fuel-cycle processes are presented. Long-range estimates of the demands for various fuel-cycle services and materials are also presented. 15 references. (auth)

39266 (A/CONF.49/P-71) PLUTONIUM UTILIZATION IN LIGHT WATER REACTORS. Dawson, F. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.); Astley, W. C. (Philadelphia Electric Co., Pa.); Haley, J. (Westinghouse Electric Corp., Pittsburgh, Pa.); Tomonto, J. R. (United Nuclear Corp., Elmsford, N. Y.); Trocki, T. (General Electric Co., San Jose, Calif.). Sep 1971. 17p. (CONF-710901-13; BNWL-SA-3849). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Programs conducted in the U.S.A. which will provide the technological basis for safe and economic recycle of the Pu in light-water reactors are described. In recent years the USAEC Pu program has emphasized reactor neutronics, fuel-cycle analysis, and fuel behavior in light-water reactors. A large number of experiments have been conducted in critical facilities, the Plutonium Recycle Test Reactor, the Experimental Boiling Water Reactor, Saxton, and other test reactors. Analysis of these experiments, correlation with theory, and application to commercial power plants indicate substantial neutronic differences between U and Pu fuels, but no significant design limitations are seen. Also, irradiations of significant quantities of PuO_2–UO_2 fuels show performance equal to that of UO_2 fuels. Industry has initiated studies on the technical and economic parameters influencing the commercial utilization of Pu which include fuel-fabrication development, physics methods development, fuel-cycle analyses, nuclear design and irradiation experiments. The Westinghouse–USAEC Saxton Pu experiment will produce peak fuel exposures of 50,000 MWd/ton by early 1972. The Edison Electric Institute has programs with General Electric and Westinghouse to demonstrate Pu recycle in a large boiling-water reactor and pressurized-water reactor. As part of these programs, General Electric and Westinghouse have inserted PuO_2–UO_2 fuels in Big Rock Point boiling-water reactor and San Onofre pressurized-water reactor, respectively. In addition, it is planned to use mixed-oxide fuel in four assemblies of the initial loading for Vermont Yankee. In a cooperative program between United Nuclear Corporation and Commonwealth Edison, Dresden 1 boiling-water reactor has been operating since the fall of 1969 with 11 fuel assemblies containing PuO_2–bearing rods. As part of each of the above demonstration programs, selected rods are removed at various stages of exposures for careful examination and evaluation. Results to date of the United States programs indicate that PuO_2–UO_2 fuel can be designed to function interchangeably with U reload fuel, with flexibility to accommodate varying amounts of Pu. 35 references. (auth)

39267 (A/CONF.49/P-74) COOPERATION OF UTILITIES AND SUPPLIERS IN FUEL MANAGEMENT. Richards, R. B. (General Electric Co., San Jose, Calif.); Gilleland, J. E. (Tennessee Valley Authority, Chattanooga); Behnke, W. (Commonwealth Edison, Chicago, Ill.); Grube, R. M. (Yankee Atomic Electric Co., Westboro, Mass.). Sep 1971. 8p. (CONF-710901-50). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

To satisfy the traditional requirements for the utilization of electric power, varying degrees of cooperation among the power producer and the supplier of the nuclear reactor and its fuel are required. Some of the plans and practices now being used or being considered for use in the United States are described. The discussion is primarily on in-reactor fuel management. Out-of-reactor fuel supply management is discussed only as it is related directly to the operation of the reactor and its fuel system. The extent of cooperation required between the supplier and the user is illustrated by a short review of the type reactor system and the power generation system operated by the power producer. (auth)

39268 (A/CONF.49/P-75) ECONOMIC OPTIMIZATION IN NUCLEAR FUEL MANAGEMENT. Stoller, S. M. (Stoller (S. M.) Corp., New York); Bartnoff, S. (General Public Utilities, Parsippany, N. J.); Philipp, H. (Niagara Mohawk Power Corp., Syracuse, N. Y.); Walke, G. (Consumers Power Co., Jackson, Mich.). Sep 1971. 12p. (CONF-710901-15). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Optimizing fuel-cycle economics both in the longer range for fuel-supply planning and in regard to short-term operating decisions, such as prediction of cycle length and reload batch enrichment, all within the technical limitations of heat-transfer and power distribution, is the objective of a good fuel-management system. These considerations also place a premium on computational techniques. The nature of these computer programs and the procedures for training utility personnel in their use are discussed. 8 references. (auth)

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39269 (A/CONF.49/P-837) UTILIZATION OF THE THORIUM CYCLE IN THE HTGR. Stewart, H. B.; Dahlberg, R. C.; Goeddel, W. V. (Gulf General Atomic, Inc., San Diego, Calif.); Trauger, D. B.; Kasten, P. R.; Lotts, A. L. (Oak Ridge National Lab., Tenn.). Sep 1971. 19p. (CONF-710901-29). Dep. NTIS.

Prepared for fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Th–U fuel cycle forms the basis for high-temperature gas-cooled reactor (HTGR) developments in the U.S.A., which have resulted in the construction and operation of the 40-MW(e) Peach Bottom Atomic Power Station, Unit 1, and the near completion of the 330-MW(e) Fort St. Vrain Nuclear Generating Station. The reference fuel element for the HTGR is a graphite prismatic block containing interspersed coolant channels and fuel holes filled with rods containing coated fuel particles bonded together by a carbonaceous matrix. With ^{233}U recycle, the Th–U cycle appears to be 0.1 to 0.2 mill/kWh cheaper than the low-enrichment cycle. The use of Pu rather than fully enriched U as a makeup material is also attractive, the indifference value for Pu being typically $9 to $10 per gram of fissile material in such applications. The establishment of reprocessing and refabrication facilities and the recycle of ^{233}U are important both to the economics of the Th cycle and to its impact on resource conservation. The reprocessing operation begins with head-end operations that break down the elements, separate the fuel particles from the carbon mass, separate particles by screening as desired, and remove the carbon and SiC coatings. This is followed by the dissolution of the Th and U components. Spent ^{235}U is recovered and either sold or recycled. Fission products, ^{233}U, and Th are separated by the acid thorex solvent-extraction process. The ^{233}U is reconstituted into spherical oxide particles by a sol-gel process in a remote facility. The ^{233}U-bearing particles are coated, combined with Th-bearing particles, formed into fuel rods, and loaded into premachined graphite blocks, all with remotely operated equipment. The design, development, and testing of the processes and equipment to accomplish these operations are important objectives of the U. S. program. A shielded facility, the Th–U recycle facility (TURF), was built for this work. The program will provide final criteria and bases for design of a commercial recycle plant. 11 references. (auth)

Safety and Siting

Refer also to abstract 39324.

39270 (A/CONF.49/P-39) STATUS OF UNITED STATES ATOMIC ENERGY COMMISSION WATER-REACTOR SAFETY RESEARCH AND DEVELOPMENT PROGRAMS. Brockett, G. F.; Haire, J. C.; Johnson, S. O. (Idaho Nuclear Corp., Idaho Falls); Case, E. G.; Rosen, M. A. (Atomic Energy Commission, Washington, D. C.). Sep 1971. 12p. (CONF-710901-52). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The U. S. effort is directed toward providing the analytical techniques and associated experimental information that will materially increase the confidence level of reactor safety assessment in the siting, design, construction, and operation of nuclear-reactor systems. The current program emphasizes (1) accident prevention, (2) engineered safety system investigations, (3) fuel-cladding-failure studies, and (4) development of experimentally verified analytical techniques. The products of these programs lead to the development and application of comprehensive reactor standards and codes. 47 references. (auth)

39271 (A/CONF.49/P-40) TECHNICAL SAFETY ISSUES FOR LARGE NUCLEAR POWER PLANTS. Hanauer, Stephen H. ([Division of Licensing and Regulation] (AEC), Washington, D. C.); Morris, Peter A. (Division of Reactor Licensing (AEC), Washington, D. C.). Sep 1971. 16p. (CONF-710901-56). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Safety reviews by applicants and the USAEC regulatory staff, together with the USAEC Advisory Committee on Reactor Safeguards, have resulted in a number of changes in plant design or operation. Some of the most significant of these changes and the reasons for them are discussed. Examples are given that relate to site and environmental characteristics, reactor design, coolant-system design and performance, design of the containment and other structures, design and performance of engineered safety features, instrumentation and power-system design, and quality-assurance procedures. (auth)

39272 (A/CONF.49/P-41) RECENT DEVELOPMENTS IN THE UNITED STATES LIQUID-METAL FAST BREEDER REACTOR SAFETY PROGRAM. Pressesky, A. J. (Division of Reactor Development and Technology (AEC), Washington, D. C.); Wolfe, B.; Peterson, R. E. (Hanford Engineering Development Lab., Richland, Wash.); Simmons, W. R.; Fischer, G. J. (Argonne National Lab., Ill.); Pflasterer, G. R. (General Electric Co., Sunnyvale, Calif.); Morewitz, H. A. (Atomics International, Canoga Park, Calif.). Sep 1971. 13p. (CONF-710901-2). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Safety development for the liquid-metal fast breeder reactor in the U.S.A. is based upon the principle of defense in depth. A primary requisite of this approach is that the design, construction, and operation of reactor plants be in accordance with high-quality standards and well-understood technical bases, thus assuring the highest possible reliability and safety. Safety features not needed for normal operation are provided to accommodate mechanistically describable failures and malfunctions that cannot be completely precluded by design. Finally, consequence-limiting features are provided, such as containment, to protect against events that cannot be characterized as absolutely impossible, even though they are of such remote probability that credible causative mechanisms cannot be defined. The major U. S. development emphasis is on technology related to off-normal operating conditions that have previously been postulated as potentially leading to major accidents. Lesser emphasis is placed on the accommodation of hypothetical consequences of undefined events. Recent progress leads to optimism that the safety of liquid-metal-cooled fast breeder reactors can be firmly established without undue economic penalties: the Doppler effect has been established theoretically and experimentally as a major prompt negative feedback mechanism for oxide-fueled liquid-metal fast breeder reactors; analysis and experiment have provided a basis for understanding the effects of sodium voiding; Transient Reactor Test experiments have shown that the work energy availability from fuel–coolant interactions is much smaller than the thermodynamic maximum; significant sodium superheat is not expected under reactor operating conditions; gas escaping from fuel pins has been shown experimentally to be an unlikely source of fuel-failure propagation; improved and experimentally verified accident-analysis methods have been developed; modeling of the accident response of reactor internals, vessels, vessel covers, and support structures has been developed; theoretical aerosol models have been confirmed by engineering scale experiments, which should reduce present conservative approaches. 59 references. (auth)

39273 (JAERI-1193) STUDIES ON AN ENVIRONMENTAL MONITORING SYSTEM FOR THE RADIOLOGICAL DISASTERS DUE TO A REACTOR ACCIDENT. Kadokawa, Masayoshi (Japan Atomic Energy Research Inst., Tokyo). Apr 1970. 36p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Some numerical design problems were studied to find an ideal system of environmental monitoring, based on the estimation of a γ-ray sky-shine, and complex radio-ecological effects. The magnitude of radiological disaster was defined as the dose-commitment to the thyroid gland, a critical organ, of (standard) resident at the most contaminated spot. Provided that the dose corresponding to an action level against the radiological disaster is taken as 100 rems for the thyroid gland, and the inhalation time is 10 hr, it is ideal to set γ-ray detectors 1.6 km or more away from the reactors at about 400 m intervals, and in addition radioactive-aerosol monitors to collect iodine-131, shielded against the sky-shine, 1 km from the reactors at 1 km intervals. A method was also developed of determining the optimum distribution of monitoring instruments under complicated constraints, utilizing the dynamic programming technique. The efficiency of a monitoring system was defined as the probability to detect a fission products cloud in a radiological disaster, as functions of the action level, and position, alarm level and failure rate of monitoring instrument, with climatologic data. 25 references. (auth)

39274 (MSAR-68-109) COMBUSTION LIMITS OF HYDROGEN–OXYGEN–NITROGEN–STEAM MIXTURES. Final Report. Greer, J. S.; Rankin, R. L. (MSA Research Corp., Evans City, Pa.). 11 Jun 1968. 43p. Dep. NTIS.

The combustion limits of steam-diluted hydrogen–oxygen mixtures were determined at 1150 psig in a 0.5 cu ft stainless steel test cell. Gas samples were extracted at temperature to establish the composition of combustible mixtures. Temperature and pressure excursions were recorded throughout most of the tests. A stoichiometric hydrogen–oxygen mixture confined at 950°F and 1150 psig becomes combustible when the mixture contains between 90 and 95% steam. An excess of hydrogen in mixtures contained at 950°F increased the combustion limit to >95% steam. Establishing the combustion limits of hydrogen–oxygen mixtures at 950°F resolves into a problem of preventing thermal initiation in the mixture. When the temperature is reduced to 750°F, com-

bustion occurs in stoichiometric mixtures containing 80–85% steam. Increasing the hydrogen concentration to $3H_2 + O_2$ or $4H_2 + O_2$ at 750°F had an insignificant effect on the combustion limit. Reducing the temperature of a stoichiometric mixture to 550°F lowered the combustion limit to between 65 and 70% steam. (16 references) (auth)

39275 (ORNL-NSIC-88) INDEXED BIBLIOGRAPHY OF LITERATURE ON SEISMIC CONSIDERATIONS IN THE SITING OF NUCLEAR FACILITIES-1. McClain, W. C.; Myers, O. H. (Oak Ridge National Lab., Tenn.). Jun 1971. Contract W-7405-eng-26. 374p. Dep. NTIS.

Abstracts of reports and literature concerning seismological considerations in the siting of nuclear facilities are presented. A keyword index and an author index to the abstracted material are also included. (D.C.C.)

39276 (RISO-M-1374) THE CAUSE/CONSEQUENCE DIAGRAM METHOD AS A BASIS FOR QUANTITATIVE ACCIDENT ANALYSIS. Nielsen, Dan S. (Danish Atomic Energy Commission, Risoe. Research Establishment). May 1971. 27p. Dep. NTIS (U. S. Sales Only).

A graphical method for analyzing relevant accidents in complex nuclear installations is presented. The method is a proposal for an expedient presentation of the logical connections between a "spectrum" of accident causes and a "spectrum" of relevant consequences, e.g. expressed in terms of fission products released to the population. Besides being a tool used in connection with the elimination of these consequences and their causes, the method serves as a basis from which the probability of occurrence of the individual consequences may be evaluated. The main principle of the method involves the concept of a "critical event," which for example may often be described as a transgression of the safety limit of a vital reactor parameter, followed by two fault tree methods used in a combined way to determine the logical connections between the causes of the critical event and the possible consequences of it. (7 references) (auth) (Denmark)

39277 DYNAMIC STABILITY OF CYLINDRICAL SHELLS SUBJECTED TO SONIC WAVES DUE TO A LOSS-OF-COOLANT REACTOR ACCIDENT. Bohm, George J.; Steck, Elmar A. (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng.; 44: No. 3, 301-9(Jun 1971).

During a postulated loss-of-coolant accident (LOCA) (complete severance of a primary coolant pipe) the upper barrel of the reactor internals in a pressurized water reactor is subjected to dynamic differential pressures. In case of a sudden hot-leg break, the initial disturbance is a compressive triangular pulse approximately uniformly distributed with the pressure rising to a peak of 250 psi in ~0.010 sec and dropping to 0 in 0.020 sec. The possible response under this impulsive compressive pressure is dynamic instability (buckling) and/or large deflections of the upper core barrel. The dynamic response of the barrel under the actual triangular pulse is analyzed and, to obtain margins of safety, compared with the response to assume more severe loading conditions. The response of the barrel to the pressure pulse consists initially in a uniform radial inward movement and results, therefore, in compressive hoop stresses (hoop response). Deviations of the barrel shape from the circular cross section (initial imperfections of the order of the manufacturing tolerances) result in circumferential bending moments and the excitation of higher shell modes (flexural response). For the actual triangular pulse the analysis shows that the dynamic effects are small and the occurring stresses and deflections are close to the values obtained by loading the shell statically with the pressure p^*_{max}. For the step loads that are applied to investigate the margin of safety of the shell, the dynamic effects are no longer negligible and result in stresses above yield for $p^* = 350$ psi and $p^* = 500$ psi. However, for these loading cases, the maximum deflections remain on the order of magnitude of the initial imperfections and the barrel is therefore considered stable. 27 references. (auth)

39278 STUDY OF COOLANT TRANSIENTS DURING A RAPID FISSION GAS RELEASE IN A FAST REACTOR SUBASSEMBLY. Chawla, T. C.; Hoglund, B. M. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 44: No. 3, 320-44(Jun 1971).

The flow transients as initiated by rapid gas release are studied both experimentally and analytically. The mathematical model developed considers a multiple pin failure in a fast-reactor subassembly. In formulating the model, it is assumed that the released gas fills the subassembly cross section uniformly and that the coolant flow is incompressible. The model considers the inertial contribution of the liquid columns beyond the pin assembly, as well as the three-dimensional flow effects in the inlet and outlet plenums. In the application of the model to out-of-pile simulation loops, or in-pile test loops, points of departure in hydraulic simulation of the actual reactor conditions can be taken into account. A quantitative criterion for valid application of the model is obtained in terms of breach size, number of pins ruptured, initial gas plenum pressure and temperature, and subassembly operating conditions. The predictions of the flow transients obtained by means of the model agree well with the experimental data. An example of the application of the model to a reactor configuration is given using an FFTF fuel subassembly. 16 references. (auth)

39279 EXPERIENCE IN REACTOR MALFUNCTION DIAGNOSIS USING ON-LINE NOISE ANALYSIS. Fry, D. N. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 10: No. 3, 273-82(Mar 1971).

Experience has been obtained with a continuous neutron noise monitor at the High Flux Isotope Reactor (HFIR) and with neutron and pressure noise monitors at the Molten Salt Reactor Experiment (MSRE). Results at the HFIR show that the neutron noise monitor can be used to detect control rod bearing failures. The neutron noise monitor at the MSRE gave a continuous indication of the amount of helium void in the fuel salt circulated through the core. The value of noise analysis as a diagnostic aid was shown when the pressure noise monitor at the MSRE aided in a diagnosis of off-gas line restrictions 1 week before other instruments confirmed the blockage. These experiences show that noise analysis can be used for some types of reactor malfunction diagnosis and parameter measurement when other methods cannot be used either because of the environment (radiation or temperature) or a lack of space for sensors. (21 references) (auth)

Power Conversion Systems

39280 (CEA-N-1392) SAFETY STUDY OF SODIUM-HEATED STEAM GENERATORS: FORMULATION OF THE PHENOMENA AND RESOLUTION OF THE EQUATIONS WITH AN ANALOG COMPUTER. Cusset, Jean (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Nov 1970. 113p. (In French). Dep. NTIS (U. S. Sales Only).

The study of Na heated steam generator safety is achieved from mockup experiments. The equations which rule the phenomena and their resolution by means of an analog computer are described. The equations are derived from fluid mechanics and describe wave propagation in Na. The equations are partial differential equations with two independent variables. Resolution with an analog computer requires a transformation into an approximate differential system, with the time as a single independent variable, the space variable being expressed in its discrete form. The results obtained are compared with the experimental results. (France)

39281 (CONF-710315-2) SODIUM-HEATED MODULAR STEAM GENERATOR DESIGN AND DEVELOPMENT. McDonald, J. S.; Casey, D. F. (Atomics International, Canoga Park, Calif.). [Nov 1969]. 33p.

From Conference on fast reactors; Palo Alto, Calif. (7 Mar 1971).

Design criteria considered for LMFBR steam generators are discussed. Included among the areas discussed are materials and processes, tube vibration, tube leak effects, and design thermal transients. The trade studies which led to the selection of the steam generator design are summarized, and particulars on designs for the demonstration plant and 1000 MW(e) plants are presented. The supporting development program is discussed, with particular emphasis on the manufacture of a 26.7 MW(t) rated modular steam generator prototype. This prototype is to be tested in the Sodium Component Test Installation of the AEC's Liquid Metal Engineering Center. (11 references) (auth)

39282 (ORNL-TM-2953) A NEW APPROACH TO THE DESIGN OF STEAM GENERATORS FOR MOLTEN SALT REACTOR POWER PLANTS. Fraas, A. P. (Oak Ridge National Lab., Tenn.). Jun 1971. Contract W-7405-eng-26. 69p. Dep. NTIS.

A new type of steam generator was devised to meet the special requirements of high-temperature liquid metal and molten salt reactor systems. The basic design concept is such that boiling heat transfer instabilities and their attendant severe thermal stresses are avoided even for a temperature difference of as much as 1000°F between the feedwater and the high-temperature liquid, thus giving good control characteristics even under startup conditions. This is accomplished by employing a vertical reentry tube geometry with the feedwater entering the bottom of the inner small diameter tube (~1/4 in. diam) through which it flows upward until evaporated to dryness. The slightly superheated steam emerging from the top of the small central tube then flows back downward through the annulus between the central tube and the outer tube. A portion of the heat transferred from the high-

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temperature liquid to the superheated steam in the annulus is in turn transferred to the water boiling in the central tube. Design studies indicate that this type of boiler not only avoids thermal stress and salt freezing problems but it also gives a relatively compact and inexpensive construction. Further, it appears to make possible a simple plant control system with exceptionally good plant response to changes in load demand. (20 references) (auth)

39283 SELECTION OF STEAM GENERATOR TUBING MATERIAL FOR THE WESTINGHOUSE LMFBR DEMONSTRATION PLANT. Ray, W. E.; Schrock, S. L.; Shiels, S. A.; Thomas, K. C. (Westinghouse Electric Corp., Madison, Pa.). Nucl. Technol.; 11: No. 2, 222-31(Jun 1971).

The Westinghouse steam generator is of the "single tube once-through" type; its basic design attributes and target operating conditions are given. It is entirely within the confines of this design and these operating conditions that Incoloy-800 was selected as the reference tubing material. The materials engineering aspects of these alloys are presented. For convenience, the discussion is divided under the following headings: (1) mechanical property comparison; (2) sodium corrosion performance; (3) metallurgical stability; (4) water/steam corrosion performance; and (5) sodium/water reactions. Relevant attributes of candidate tubing alloys are compared under each heading. The candidate materials are: (1) Incoloy-800; (2) Inconel-600; (3) Inconel-625; (4) Type 304 Stainless Steel; (5) Type 316 Stainless Steel; (6) $2\frac{1}{4}$ Cr–1 Mo Ferritic Steel; and (7) Stabilized Chromium–Molybdenum ferritic steels (principally modified $2\frac{1}{4}$ Cr–1 Mo). (21 references) (auth)

Research and Test Reactors

Refer also to abstracts 39208, 39213, 39233, 39275, and 39311.

39284 (A/CONF.49/P–53) RESEARCH EXPERIENCE WITH THE HIGH FLUX ISOTOPE REACTOR (HFIR) AND THE HIGH FLUX BEAM REACTOR (HFBR). Snell, Arthur H. (Oak Ridge National Lab., Tenn.); Hastings, J. M.; Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.). Sep 1971. 20p. (CONF-710901–55). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Both the High Flux Isotope Reactor (HFIR) at Oak Ridge and the High Flux Beam Reactor (HFBR) at Brookhaven supply neutron beams intense enough for triple-axis neutron spectrometry, whereby the neutrons are first monochromatized and/or polarized, then scattered from the sample, and finally reanalyzed as to energy and/or polarization. In addition to classical structure work, magnetic studies can be made pertaining to atomic form factors and moments, temperature- and composition-dependent magnetic structural transitions in elements and alloys, long-range ordering, spin wave spectroscopy, and the measurement of magnon and phonon dispersion curves. Illustrative examples are given. At HFBR, fast and slow mechanical choppers also are installed. The former is used for capture gamma-ray spectrometry at selected neutron resonances, and the latter for work with neutrons of long wavelength. The HFIR was built primarily for production of transplutonium isotopes and is supplemented by an elaborate chemical plant. Some production figures for the period July 1969 to July 1970 are ^{244}Cm, 50 g; ^{252}Cf, 54 mg; ^{253}Es, 0.4 mg; ^{257}Fm, 5×10^8 atoms. Unusual but useful isotopes, such as ^{32}P, ^{43}K, and ^{67}Cu, can also be made in HFIR in curie amounts. The reactor characteristics of HFIR are as follows: 100 MW; H_2O moderated and cooled; built to maximize thermal flux in a central flux trap; undisturbed central thermal flux, 4×10^{15} n/cm^{2}s over a 5-liter volume; fast flux (>10^5 eV), 1.2×10^{15} n/cm^{2}s; four major beam holes. The reactor characteristics of HFBR are: 40 MW; D_2O moderated and cooled; built for a large volume at high flux to supply experimental beam holes; maximum thermal flux, 7×10^{14} n/cm^{2}s surrounding core; epithermal and fast flux (>5 eV), 1.5×10^{15} m/cm^{2}s; nine major beam holes, two of them dual. 23 references. (auth)

39285 (CEA-N–1415) FRANCO–BRITISH EXPERIMENTAL LOOP: TEMPERATURE EVOLUTION AFTER BLOWER STOP. Trimouille, Claude (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Feb 1971. 70p. (In French). Dep. NTIS (U. S. Sales Only).

The resolution of a heat conduction problem within the flux area of an experimental loop without blower cooling is presented. The mathematical model consists of a set of nonlinear ordinary differential equations with variable coefficients. An E.A.I. 8945 hybrid computer is used. The analog section simulates the process; the digital section of this computer verifies the simulation cabling, computes the potentiometer coefficients, and sets the initial conditions using the H.O.I. program. (auth) (France)

39286 (CONF-710416–, Paper 8) TRAINING OF HIGH FLUX ISOTOPE REACTOR MAINTENANCE PERSONNEL. McCord, R. V.; Poteet, K. H.; Weir, R. C. (Oak Ridge National Lab., Tenn.). 59

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

The training programs for maintenance personnel at the ORNL High-Flux Isotope Reactor are described. Three types of maintenance personnel are required for operation of the HFIR. These are reactor operators, craftsmen, and instrument technicians. The reactor operators perform all remote maintenance work in the reactor vessel and in the storage pools. The operators also man the control room, manipulate the reactor controls, make routine checks, and operate all reactor auxiliary equipment. The craftsmen are responsible for performing all mechanical and electrical maintenance at the reactor. The instrument technicians are responsible for all instrument maintenance at the reactor. (D.C.C.)

39287 (CONF-710416–, Paper 16) THE DEVELOPMENT OF A SELF-STUDY PROGRAM FOR CERTIFYING AND RETRAINING REACTOR OPERATIONS STAFF AT ORNL. Hamrick, T. P. (Oak Ridge National Lab., Tenn.). 20p.

From Symposium on training of nuclear facility personnel; Gatlinburg, Tenn. (19 Apr 1971).

In Papers presented at the symposium on training of nuclear facility personnel (1971).

39288 (EURFNR–847) THR HSD LOOP: A STEAM LOOP FOR CAN DAMAGE TESTS. Jacobi, S.; Rautenberg, I.; Beitner, H.; (and others) (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Translation of report KFK–1255. 79p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The release of fission products and fuel particles from a failed reactor fuel element, their transport and detection in steam, their deposition and decontamination of circuit components, the corrosion resistance of reactor materials, and the behavior of failed fuel elements are important design parameters of steam cooled reactors. For experiments of this kind a superheated steam test loop has been installed at the FR 2 reactor at Karlsruhe. This loop consists of a steam generator unit, an in-pile test bed for accommodation of the fuel pins, and an expansion unit, condenser and low pressure section. The loop is controlled automatically and is run with indirect supervision. A two-out-of-three selection circuit actuates shutdown of the FR 2 reactor as soon as unsafe operating conditions are approached. 12 references. (auth)

39289 (IAEA–119, 5p.) INSTRUMENTATION FOR SODIUM MEASUREMENTS IN THE RAPSODIE REACTOR. FUNCTIONING OF THE PRINCIPAL COMPONENTS. Lions, N.; Valantin, M. (International Atomic Energy Agency, Vienna (Austria)). 1970. (In French). (CONF-691116–20). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

39290 (LB/G–3002) EXPERIENCE IN THE OPERATION OF THE MR MULTI-LOOP RESEARCH REACTOR. Goncharov, V. V.; Ryazantsev, E. P.; Babulevich, E. N.; Novikov, I. M.; Egorenkov, P. M.; Fishevskii, V. K.; Kruglov, A. B.; Zakharov, L. K. (Institut Atomnoi Energii, Moscow (USSR)). Translated by R. R. Inston (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE–1924. 26p. (CONF-691060–5). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

The principal results are given of five years' experience in the operation of the MR reactor and its loop installations. Modifications and improvements made to the operational and other systems of the reactor are described. Data are presented on the dosimetry arrangements in the MR reactor. 7 references. (auth)

39291 (LB/G–3003) EXPERIMENT LOOPS IN THE MR REACTOR. Ryazantsev, E. P. (Institut Atomnoi Energii, Moscow (USSR)). Translated by R. R. Inston (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE–1923. 43p. (CONF-691060–18). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

A description is given of the loop installations of the MR reactor and their experiment channels of different types. The problems of their development and assembly are discussed. A classification of experimental loops is presented, and the basic concepts involved in

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testing and research work carried out with the aid of these installations are discussed, together with methods of organizing and executing the work. The problems of interaction between loop installations and research reactors are examined. The characteristics of the loop installations and some data on reactor research carried out in the MR make it possible to evaluate the experimental capabilities of this multi-loop materials-testing reactor and its degree of utilization. 4 references. (auth)

39292 (LB/G–3004) METHODS OF TESTING STRUCTURAL MATERIALS IN THE MR REACTOR. Amaev, A. D.; Ivanov, A. N.; Kuznetsov, V. N.; (and others) (Institut Atomnoi Energii, Moscow (USSR)). Translated by R. R. Inston (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE–1917. 29p. (CONF-691060–1). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

A description is given of the design of the containment devices used in irradiating and testing materials in the MR reactor at different neutron fluxes and temperatures. Some experimental procedures that are used for in-pile investigations are discussed, notably procedures for creep testing, temperature control, and corrosion tests. 5 references. (auth)

39293 (LB/G–3005) TESTING EXPERIMENTAL FUEL ASSEMBLIES FOR POWER REACTORS IN THE MR REACTOR (EXPERIMENTAL PROCEDURES AND SOME RESULTS). Goncharov, V. V.; Ryazantsev, E. P.; Goncharov, L. A.; Kruglov, A. B. (Institut Atomnoi Energii, Moscow (USSR)). Translated by R. R. Inston (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE–1918. 20p. (CONF-691060–6). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

Experimental procedures for testing fuel elements and materials for power reactors in loop installations are discussed. Some specific examples of setting up and carrying out loop experiments are given. Brief results are presented from tests in the MR reactor on fuel elements made of sintered UO_2 in Zr alloy cans for water-moderated water-cooled and boiling power reactors. (auth)

39294 (LB/G–3006) STUDY OF THE BEHAVIOUR OF ZIRCONIUM ALLOYS IN WATER AND STEAM–WATER MIXTURES IN THE MR REACTOR LOOPS. Amaev, A. D.; Ambartsumyan, R. S.; Goncharov, V. V.; Ivanov, E. G.; Lebedev, L. M.; Ryazantsev, E. P. (Institut Atomnoi Energii, Moscow (USSR)). Translated by J. A. Bartlett (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE–1926. 13p. (CONF-691060–2). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

Results are presented of an investigation of Nb–Zr and Nb–Ni–Zr alloys after tests in pressurized water and a steam-water mixture in the MR reactor loops. The tests were carried out on samples of tubes and fuel-element rods of different design. It was found that irradiation caused a marked deterioration in the properties of the Nb–Ni–Zr alloy. Under the same conditions the Nb–Zr alloy was far less sensitive to irradiation. (auth)

39295 (LB/G–3007) DETERMINATION OF NEUTRON FLUXES IN THE MR REACTOR LOOPS AND MATERIALS-TESTING CHANNELS. Vikhrov, V. I.; Borodin, A. V.; Perevezentsev, V. N. (Institut Atomnoi Energii, Moscow (USSR)). Translated by J. A. Bartlett (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE–1912. 21p. (CONF-691060–23). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

Using threshold detectors, energy spectra were studied and fast-neutron fluxes were measured in three typical MR-reactor positions: in the fuel-element holes, in the Be block, and in the side-reflector holes. It was found that the maximum flux of neutrons with $E > 0.5$ MeV was $(2.4 \pm 0.4) \times 10^{14}$ n/cm^{2}s for the 2000 kW fuel-element holes, $(1.2 \pm 0.2) \times 10^{14}$ n/cm^{2}s for the Be block hole at a total power of 8,000 kW from the four surrounding fuel elements, and approximately 1.5×10^{12} n/cm^{2}s for the side-reflector holes. To determine fast-neutron fluxes acting on the irradiated steel structures taken from the reactor, experimental methods have been developed using the structural materials. Neutron fluxes were determined from the amount of ^{54}Mn accumulated in the structural material as a result of the ^{54}Fe(n,p)^{54}Mn threshold reaction. The ^{54}Mn activity was measured by an absolute method using γ spectrometers with NaI(Tl) and Ge(Li) detectors. Some results of fast-neutron flux measurements are presented for the reactor loop channels. The neutron fluxes were determined from the ^{54}Mn accumulation in the fuel-element claddings. 12 references. (auth)

39296 (LB/G–3008) EXTENDING THE EXPERIMENTAL CAPABILITIES IN REACTORS OF THE IRT TYPE. Goncharov, V. V.; Glukhov, A. M.; Egorenkov, P. M.; Chernyshevich, V. N.; Shavrov, P. I.; Yashin, A. F. (Institut Atomnoi Energii, Moscow (USSR)). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE–1920. 46p. (CONF-691060–7). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

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The project for redesign of the IRT reactors is described. The basis of the IRT-M project is the use of new fuel elements and a new cooling system. The principal thermal and physical parameters of the IRT-M reactor are given. Experience of dismantling and assembly work in the reactor pool is described, together with the radiation conditions met in the course of reconstruction of the IRT reactor which had operated for more than seven years. Possibilities of raising the power of the IRT-type reactors to 8 MW are discussed. 10 references. (auth)

39297 (LB/G–3009) EXPERIENCE IN THE OPERATION AND USE OF THE IRT-M REACTOR AT THE I. V. KURCHATOV INSTITUTE. Chernyshevich, V. N.; Yashin, A. F. (Institut Atomnoi Energii, Moscow (USSR)). Translated by J. A. Bartlett (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE–1921. 28p. (CONF-691060–3). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

Experimental facilities in the modernized IRT-M reactor are described. An example is given of the use of the reactor for capsule experiments (in the core). The main operating characteristics of the reactor are listed and also the results of measuring the temperature of the fuel-element wall during normal operation and on emergency shutdown of the primary-circuit circulating pumps. 4 references. (auth)

39298 (LB/G–3010) DETERMINATION OF SOME PHYSICAL PROPERTIES OF LOOPS AND EXPERIMENT HOLES IN THE MR REACTOR. Goncharov, L. A.; Kruglov, A. B.; Ryazantsev, E. P. (Institut Atomnoi Energii, Moscow (USSR)). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE–1922. 29p. (CONF-691060–8). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

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Several methods of determining the neutron properties of loops containing fuel assemblies and of positions for irradiating structural materials in the MR reactor are described. Data are given concerning the influence of various factors on the absolute value and distribution of thermal and fast fluxes and on the non-uniformity of heat generation in a number of loops containing fuel assemblies under test. Methods are discussed for flattening the neutron distributions in the loops and reducing the non-uniformity of heat generation in the test assemblies. 3 references. (auth)

39299 (LB/G–3011) ORGANISATION AND PLANNING OF EXPERIMENTS IN A RESEARCH REACTOR. Tsykanov, V. A.; Fatieva, N. L.; Anokhin, I. P. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from a Russian report. 21p. (CONF-691060–19). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

Handwritten MS copy.

Methods for determining the optimum utilization of research reactor experimental facilities are presented. Irradiation programs for the SM-2 Reactor (Russia) are analyzed. (D.C.C.)

39300 (LB/G–3013) A CAPSULE RIG FOR THE IRRADIATION OF STRUCTURAL MATERIALS IN THE SM-2 REACTOR WITH TEMPERATURE CONTROL BY VARIATION OF GAS-GAP SIZE. Lobanov, G. P.; Samsonov, B. V.; Timchenko, R. A.; Tsykanov, V. A.; Shulimov, V. N. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translated by J. T. Demant (Atomic Energy Research Establishment, Harwell, Eng.), from report SRARI-P–56. 16p. (CONF-691060–17). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

The construction description and principal capsule channel characteristics destined for the construction materials irradiation under an elevated temperature (>500°C) in SM-2 reactor are given. The channel construction permits a temperature adjustment of specimens during irradiation by varying the thermal resistance value (the helium gap thickness) between specimens in which heat

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is generated, and by the reactor coolant removing this heat from the capsule channel body. 5 references. (auth)

39301 (LB/G–3014) DETERMINATION OF INTEGRATED NEUTRON FLUXES DURING IRRADIATION OF MATERIALS IN RESEARCH REACTORS. Zaletnykh, B. A.; Kormushkin, Yu. P.; Frunze, V. V. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from a Russian report. 9p. (CONF-691060–24). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

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A program at the SM-2 and MIR reactors to determine conditions of irradiation of materials and fuel elements in the experimental facilities is described. In the SM-2 reactor, which is mainly intended for materials studies, neutron fluxes and spectra in empty holes have been measured; then a physical model of the reactor is used to measure the perturbation caused by any particular loading of the experiment hole. From this information the integrated fluxes during irradiation are determined. In the MIR reactor, which is intended for fuel assembly loop tests, it is more important to know the distribution of energy evolution in the loop cells. This distribution is measured using a physical model of the reactor. Information about the neutron spectra can be calculated and integrated fluxes determined from the energy evolution. 9 references. (auth)

39302 (LB/G–3015) POWER CONTROL FOR LOOP ASSEMBLIES IN THE MIR REACTOR. Tsykanov, V. A.; Kormushkin, Yu. P.; Zaletnykh, B. A.; Kuprienko, V. A.; Klochkov, E. P. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from a Russian report. 11p. (CONF-691060–20). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

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On the basis of information obtained in the study of characteristics and operation of the MIR loop reactor, it is found to be necessary to control the energy evolution in each loop channel separately in order to deal with one of the basic problems of a multi-loop research reactor: the simultaneous establishment and maintenance during the run of the necessary conditions in all the loop channels which are placed in the reactor. The means of control used for this purpose must provide both the initial adjustment of conditions and also correction of the energy distribution in the core during the run in order to maintain this adjustment. The possibilities of such means of control of loops are described as regular reactor control rods, absorbing screens both continuous and in the form of rods placed around the loop channel, variation of the composition of the medium in the loop cell and variation of the fuel charge in the channels surrounding the loop channel. (auth)

39303 (LB/G–3016) EXPERIMENTAL DETERMINATION OF NUCLEAR HEATING VALUES IN SM-2 REACTOR HOLES. Neverov, V. A.; Samsonov, B. V.; Tsykanov, V. A. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from report SRARI-P–37. 38p. (CONF-691060–13). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

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The results of measurements are analyzed to provide the most probable nuclear-heating values caused by absorption of radiation energy by samples of materials placed in experiment holes of the SM-2 reactor. Possible fluctuations of heating values in these holes have been investigated, leading to some recommendations for the elimination of particular causes of instability. Distributions of nuclear heating along the vertical hole 6 and the horizontal hole 4 are also given; these may be regarded as typical. 5 references. (auth)

39304 (LB/G–3017) DEVELOPMENT OF METHODS AND RECORDERS FOR EXPERIMENTAL DETERMINATION OF NUCLEAR HEATING IN HIGH-FLUX RESEARCH REACTOR HOLES. Neverov, V. A.; Samsonov, B. V.; Tsykanov, V. A. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from report SRARI-P–19. 89p. (CONF-691060–14). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

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A description is given of the design of a new calorimetric apparatus and recording system for following the time variation of sample temperature and reactor power. The previously known and newly developed calorimetric methods of measuring heat generation in reactor holes are analysed. A more precise estimate of the errors of measurement in a number of methods is obtained from heat-generation measurements in several SM-2 reactor holes with a single calorimetric apparatus and various methods applied simultaneously. Results are given of a measurement of nuclear heating in reactor holes at various times after the shutdown rods have been dropped. (12 references) (auth)

39305 (LB/G–3022) MINIMISATION OF THE REACTOR COMPONENT OF PHYSICS RESEARCH COSTS. Petrov, Yu. V. ([Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut]). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from report FTI–233. 19p. (CONF-691060–16). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

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Concepts are introduced of the cost of an individual event in a physics experiment and the productivity of a reactor for physical studies. The relation between these concepts and the neutron-physics parameters of the reactor, such as power, neutron fluxes, and fuel burn-up is established. Examples are given of the application of these ideas to problems of choice of reflector, optimisation of neutron-trap dimensions and choice of optimum degree of fuel burnup. (19 references) (auth)

39306 (LB/G–3023) MONITORING OF INTEGRATED THERMAL AND FAST NEUTRON FLUXES IN EXPERIMENTAL CHANNELS OF THE VVR-M REACTOR AT THE USSR ACADEMY OF SCIENCES, A. F. IOFFE INSTITUTE OF APPLIED PHYSICS. Vasil'ev, G. Ya.; Semenov, Yu. P. ([Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut]). Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from report FTI–234. 7p. (CONF-691060–22). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

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Methods for measuring the integrated fast and thermal neutron fluxes in the vertical channels of the VVR-M reactor are described. (4 references) (D.C.C.)

39307 (LB/G–3025) A CAPSULE RIG FOR IRRADIATION OF STRUCTURAL MATERIALS IN THE SM-2 REACTOR WITH TEMPERATURE CONTROL. Lobanov, G. P.; Samsonov, B. V.; Timchenko, R. A.; Tsykanov, V. A.; Shulimov, V. N. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translated by J. T. Demant (Atomic Energy Research Establishment, Harwell, Eng.), from report SRARI-P–10. 17p. (CONF-691060–11). Dep. NTIS (U. S. Sales Only).

From Joint UK/USSR seminar on the operation and use of research and testing reactors; Harwell, England (Oct 1969).

A capsule rig has been developed for the irradiation of structural materials in the SM-2 Reactor (Russia) in-pile loops over a wide range of specimen irradiation temperatures. During an experiment, it is possible to effect control of specimen temperatures by changing the coolant flow through the rig. The maximum range of temperature control is approximately 150°C. Design parameters for the capsule rig are presented. (2 references) (auth)

39308 (LIB/Trans–352) THE HIGH FLUX REACTOR OF THE MAX VON LAUE–PAUL LANGEVIN INSTITUTE, GRENOBLE. Chatoux, Jean; Eisermann, Werner. Translated by D. J. Wilson (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Energ. Nucl. (Paris); 11: No. 2, 84-92(Mar-Apr 1969). 20p. Dep. NTIS (U. S. Sales Only).

A high flux reactor is being built in Grenoble for the Franco-German Max von Laue–Paul Langevin Institute. A flux of thermal neutrons of 15^{15} n/cm^2/sec, produced by means of a heavy water-cooled and moderated core, will be used for experiments in the fields of nuclear physics and solid physics. Design parameters are described. (auth)

39309 (NP–18809, pp 7.1-29) MATERIALS TESTING REACTOR BR2 AND ASSOCIATED FACILITIES. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

In Annual scientific report, 1969.

The experimental load of the BR2 reactor is indicated by the occupation of 52 reactor channels on average throughout 1969, compared with 45 in 1968. Some 230 devices were irradiated, not counting the standard isotope cans and measuring probes. Three large loops were operated during the year; in one, the fuel pins reached a burn-up of 50,000 MWd. t^{-1}, and in another

the fuel underwent 700 power cycles, induced by the motion of an absorber placed in a neighbouring channel. Much work was done, both to facilitate the use of the reactor by the clients, and to improve the performance or safety of the reactor such as, for instance, the testing of new fuel elements containing an increased quantity of ^{235}U with burnable poison, the ordering of new heat exchangers, which permit the power level to be raised to 100 MW, the installation of a second hydraulic rabbit for short-term irradiations in the core, the modification of the absorbers in the control rods to allow the production of ^{60}Co in the rods, and modification of the cells in the hot laboratories to allow routine production of actinium. (auth)

39310 (NP-18899) CALCULATION AND DESIGN OF A SODIUM-AIR HEAT EXCHANGER FOR THE PLANNED FAST TEST REACTOR FR 3. Spilker, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Dec 1970. 128p. (In German). Dep. NTIS (U. S. Sales Only).

Within the development work on the Fast Test Reactor FR 3, a design study was conducted for a heat transfer system removing the thermal power to ambient air. The basic data of the thermodynamic and flow design are presented for the sodium-to-air heat transfer system. The fundamental scheme of the computing program for the design of a heat transfer system is explained with a block diagram. The subprograms are indicated which are required to carry out the operation. A parameter study covering the entire field of technical interest was made to determine an optimum variant of the heat transfer system. From design restrictions and the results obtained from the parameter study a variant with the following characteristics was selected: (1) The heat transfer area consists of a helically coiled bundle having a height-to-diameter ratio of 1.8 and consists of 30 × 2 mm austenitic tubes. (2) The optimum flow velocities were found to be 70 m/sec on the air side and 2 m/sec on the sodium side. The air outlet temperature is 250°C. (3) The assembled heat transfer system is 20.5 m high and 5.4 m in diameter. (13 references) (auth)

39311 (NYO-841-24) SEMIANNUAL PROGRESS REPORT, SEPTEMBER 8, 1970-FEBRUARY 28, 1971. First, M. W.; Underhill, D. W.; Hall, R. R.; Grubner, O.; Reist, P. C.; Baldwin, T. W.; Moeller, D. W. (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab.). Contract AT(30-1)-841. 52p. Dep. NTIS.

A radioactive noble gas adsorption system was designed for the FFTF which provided for adsorption on activated charcoal and adequate holdup time for decay of a substantial fraction of the short-lived activity. Design equations were developed which permit examination of bed performance over a wide range of temperatures, pressures, and bed configurations. Efficient removal of decay heat from the early adsorption stages is important for good charcoal performance. Experiments to measure the breakthrough curves for representative commerically-available gas adsorption charcoals at ambient temperature and at -78°C to determine adsorption coefficients of radiokrypton and xenon in an inert argon carrier gas are described. Equations are developed which make it possible to estimate the effect of a rupture in a pressurized fission gas holdup bed containing activated charcoal. Calculations of the amount of Na that will be lost from the surface of a hot molten pool by volatilization and the duration of a significant rate of Na evolution are re-examined and found to contain simplifying assumptions which seriously distort conclusions. Preparations are underway to collect laboratory data which will make calculations of the period of evolution and the total Na volatilized in reduced oxygen atmospheres more accurate. Experiments to measure the thermal conductivity of deposits of Na particles are continuing in reduced oxygen atmospheres (i.e., 0-1% O_2). This program has been expanded to include measurements of the radiant heat emissivity of these same deposits. (17 references) (auth)

39312 (ORNL-TM-3400) EXTENDED CONCEPTUAL STUDY OF DISASSEMBLY-REASSEMBLY EQUIPMENT FOR EXAMINATION OF FFTF CORE COMPONENTS AND TEST ASSEMBLIES. Beckers, R. M.; Goolsby, W. W. (Oak Ridge National Lab., Tenn.). Jun 1971. Contract W-7405-eng-26. 105p. Dep. NTIS.

Prepared for Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

The results of a supplemental extended conceptual study of the disassembly-reassembly equipment to be located in the Interim Examination and Disassembly Cell at the proposed Fast Flux Test Facility in Richland, Washington, are reported. This extended study was performed to consider the effects of a reduction in the lengths of core components and test assemblies to be handled with the disassembly-reassembly equipment, addition of equipment capability for remote welding of girth joints in flow ducts of test assemblies, deletion of one set of disassembly-reassembly equipment, and the deletion of performance testing of the equipment at Oak Ridge National Laboratory. The changes to the disassembly-reassembly equipment resulting from these criteria revisions are discussed, and the critical path time-cost schedule and cost estimate are updated to reflect the revisions. Assuming a start date of July 1971, the functionally tested equipment is scheduled for delivery to Richland 36 months later with completion of liaison work scheduled for May 31, 1975. As proposed, the total estimated cost for Oak Ridge National Laboratory participation in this 4-year program is $1,444,000, including escalation. (6 references) (auth)

39313 (UARAEE-99) THERMAL FLUX DISTRIBUTION AND REFLECTOR SAVING MEASUREMENTS IN UA-RR-1 REACTOR CORE. Sabek, M. G.; El-Charif, A. I.; Nassar, S. F. (Atomic Energy Establishment, Cairo (Egypt). Reactor and Neutron Physics Dept.). 1970. 10p. Dep. NTIS (U. S. Sales Only).

The thermal neutron flux distribution along the axial direction of the UA-RR-1 reactor core was measured by the foil activation technique. The experiment was carried out in two positions of the reactor core where the effect of the control rod was at a minimum. The asymptotic region of the flux distribution was determined by constant cadmium ratio and a least squares fitting to a cosine function was conducted. The fit gave a value of (7.22 ± 0.16) cm for the axial reflector saving δ_1. It was impossible to measure the radial reflector saving because of the rigid structure of the core. The value of the axial reflector saving is in good agreement with the theoretical value. 5 references. (auth)

39314 SPECTRAL ANALYSIS OF MECHANICAL COMPONENT VIBRATIONS IN THE ESSOR REACTOR. Basile, D. (CCR-EURATOM, Ispra, Italy); Cimorelli, L.; Federico, A. Ing. Nucl.; 11: 33-51(Jan-Feb 1970). (In Italian).

An experimental study is made to confirm the validity of the efficiency of the spectral analysis method in the study of random vibrations of the mechanical components of reactors. The theoretical analysis of the frequency behavior is made on the basis of the elementary theory. The disadvantages of the spectral analysis method, the incapacity of taking mutual spectra and the reduced resolving power, are eliminated by the use of hybrid electronic devices. The results are presented and compared with the theoretical data in order to deduce an evaluation of the vibrational behavior of the fuel elements. (J.S.R.)

39315 IRRADIATION EQUIPMENT USING NEUTRON DIFFRACTION FOR STUDY OF THE SOLID STATE. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 55-6(Nov-Dec 1970). (In French).

At the Grenoble Nuclear Center, two light-water reactors were built which allow thermal neutrons to be used in neutron diffraction. Neutron diffraction equipment necessitates a thermal neutron counter, such as a BF_3 counter. A device in operation at Melusine is described which uses the diffraction of polarized neutrons; two similar devices are in operation near Siloe (30 MW). Another device operating at Melusine uses neutron chopping for studying samples under pressure. (France)

39316 IRRADIATION DEVICES OPERATING BETWEEN 50 AND 500°C IN THE MELUSINE PILE. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 57-9(Nov-Dec 1970). (In French).

The furnaces, sample holders, and in-pile solenoid are described consecutively. In order to avoid temperature differences between the thermocouples and the samples due to nuclear heating, the samples are mounted in aluminum sample holders. The coil is fixed in one of the holes of the reactor grid. It supports the end of the furnace, ensuring that the samples are in the center of the magnetic field. (France)

39317 NEUTRON IRRADIATIONS AT LOW TEMPERATURES IN MELUSINE AND SILOE. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 60-5(Nov-Dec 1970). (In French).

The cryogenic irradiation equipment of Siloe and Melusine is described: liquid nitrogen loops (80°K), liquid neon loop (30°K), and liquid helium loop (4°K). The double problem of the sample cooling and that of obtaining the necessary refrigerating power occurred. Another difficult problem is that of extracting the sample from the irradiation device, without any reheating. (France)

39318 IRRADIATION REACTORS. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 3-48(Nov-Dec 1970). (In French).

The main characteristics of the research and irradiation reactors Zoe, EL 3, Triton, Melusine, Siloe, Osiris, Pegase, Rapsodie, and Celestin are presented. (auth) (France)

39319 IN-CORE FURNACE FOR THE HIGH-TEMPERATURE IRRADIATION TESTING OF REACTOR FUELS. Anderson, E. E.; Langer, S.; Baldwin, N. L.; Vanslager, F. E. (Gulf General

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Atomic Co., San Diego, Calif.). Nucl. Technol.; 11: No. 2, 259-65 (Jun 1971).

The design and application of high-temperature in-core furnace equipment for use in a TRIGA research reactor facility is described. Investigations of the in-pile behavior of high-temperature gas-cooled reactor fuels at temperatures to 1800°C in a variable neutron flux can be conducted utilizing the TRIGA King furnace (TKF). The TKF consists of an electrically heated graphite tube and an aluminum containment vessel designed to fit an in-core TRIGA fuel element position. Associated with the furnace is a gas control and trapping system used to trap contaminants and fission gases from the fuel specimen under investigation. The TRIGA King furnace facility (TKFF) has been used for numerous studies including the fission gas and iodine release from various reactor fuels. In addition, neutron-pulsing experiments on pyrolytic-carbon-coated fuel particles have been conducted utilizing the TKFF. (6 references) (auth)

39320 COMPARISON OF EXPERIMENTALLY MEASURED AND CALCULATED RADIATION ENVIRONMENT INTERNAL TO THE PAX R-1 REACTOR. Hill, D. J.; Rankin, W. D. (Westinghouse Electric Corp., Pittsburgh). Nucl. Technol.; 11: No. 2, 175-84(Jun 1971).

Radiation data calculated by the discrete ordinates technique is compared with experimentally determined information measured on the PAX intermediate spectrum reactor which is neutronically similar to the NERVA nuclear rocket. The information compared consists of the neutron dose rate, photon dose rate, fast neutron flux (measured with ^{238}U and sulfur detectors), and thermal neutron flux (measured with bare and cadmium covered dysprosium detectors) data in the core and reflector of the reactor. The calculated results displayed the same shape as the experimental data for all detectors, and, with the exception of the bare dysprosium data in the core and the sulfur data, the calculated results had the same magnitude as the experimental results within the limits of experimental accuracies. (9 references) (auth)

39321 CRITICAL EXPERIMENTS WITH UNMODERATED PLUTONIUM OXIDE. Bierman, S. R.; Clayton, E. D. (Battelle-Northwest, Richland, Wash.). Nucl. Technol.; 11: No. 2, 185-90 (Jun 1971).

The results and analyses are presented from experiments for determining the critical parameters of Pu mixtures having concentrations that are typical of wet powders, precipitates, slurries and polymers. Experiments were conducted with fuel in which the ^{240}Pu isotopic content was 18.35 wt % and the H/Pu atomic ratio was essentially zero. The minimum critical slab thickness for a water-reflected homogeneous PuO_2–water system of this composition was determined to be 2.31 ± 0.06 cm as compared to only 1.15 ± 0.03 cm for Pu–water. For spherical geometry, the difference in critical mass between PuO_2 and Pu systems is about two. Also, in the fast neutron spectrum of this fuel, the percent change in spherical critical mass % change in ^{240}Pu content was determined to be 2.07 for the reflected case and 1.88 for the bare case. In general, the results from these experiments indicate that the values for the critical sizes and masses of Pu given in previous references should be increased for the highly concentrated systems. (7 references) (auth)

Rocket and Space Reactors

Refer also to abstract 38011 and 39320.

39322 (A/CONF.49/P–56) NUCLEAR SYSTEMS FOR SPACE POWER AND PROPULSION. Klein, Milton (National Aeronautics and Space Administration, Washington, D. C. Atomic Energy Commission, Washington, D. C.). Sep 1971. 14p. (CONF-710901–8). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

As exploration and utilization of space proceeds through the 1970s, 1980s, and beyond, spacecraft in earth orbit will become increasingly larger, spacecraft will travel deeper into space, and space activities will involve more-complex operations. These trends require increasing amounts of energy for power and propulsion. The role to be played by nuclear energy is presented, including plans for deep space missions using radioisotope generators, the reactor power systems for earth-orbiting stations and satellites, and the role of nuclear propulsion in space transportation. Experience in the missions of the 1960s is described. Designs and performance of the 70-W radioisotope generators (SNAP-27) for lunar surface scientific stations and the 25-W power supply (SNAP-19) for the Nimbus weather satellites are reviewed. The progress in space nuclear-propulsion technology has provided the basis for development of a flight-qualified nuclear rocket called NERVA. That progress and the status of NERVA development are described. The requirements imposed by flight on the engine and stage are presented. Radioisotope generators for future missions are currently being developed in the SNAP program (Systems for Nuclear Auxiliary Power), including the scientific exploration of the planets. Such systems are to be used for Jupiter probes, a Mars lander, and probes to the outer planets. Nuclear reactor power will be necessary for the higher power requirements typical of large orbiting laboratories, large communication satellites, a manned lunar base, and electric propulsion missions to interplanetary space. The technologies and developments aimed at filling these needs are reviewed. For full utilization and exploration of space, even more advanced power and propulsion concepts will be needed. An examination of these yet-to-be established concepts is also presented. (auth)

39323 MODELING OF THERMIONIC REACTOR SYSTEMS FOR DYNAMICS STUDIES. Guppy, J. G.; Brehm, R. L. (Univ. of Arizona, Tucson). Nucl. Technol.; 11: No. 1, 7-18(May 1971).

An analytical representation suitable for transient studies of a nuclear reactor containing in-core thermionic devices is formulated. The resulting model is applicable to situations involving substantial changes in system operating conditions, as would be experienced during startup transients or during large changes in the electrical load requirements while at power. The digital representation of the reactor model is tested against a comparable analog computer simulation and shown to yield better accuracy. The complex thermionic analysis is compared to a simpler converter physics description and found to be far superior in predicting the electrical characteristics of the converter for large changes in operating conditions. The thermionic analysis is also compared with transient experimental diode data over wide ranges of converter operations and shown to produce excellent agreement. Application of the model to system start-up is described for two postulated start-up approaches encompassing either constant diode voltage or constant emitter temperature. (7 references) (auth)

Process Heat and Desalination Reactors

39324 (A/CONF.49/P–50) NUCLEAR POWER FOR DESALINATION AND AGRO-INDUSTRIAL COMPLEXES. Ramey, James T. (Atomic Energy Commission, Washington, D. C.); Hammond, Philip (Oak Ridge National Lab., Tenn.). Sep 1971. 27p. (CONF-710901–59). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Nuclear electric plants can produce low-cost heat as well as electricity, and their application to desalting of seawater and production of food, fertilizer, and industrial goods could make possible highly efficient agro-industrial complexes. Such complexes can be located in areas of need without dependence on conventional fuel supply lines or water sources. Cost studies have shown the general feasibility of agro-industrial complexes, and sites in several arid regions of the world have been examined and found potentially suitable. Specialized studies of a few selected regions have been conducted or are under way, and the results of these are reviewed. (auth)

39325 (A/CONF.49/P–51) LARGE DESALTING PLANTS PROGRESS IN TECHNOLOGY-APPLICATIONS OF ATOMIC ENERGY. Sieveka, E. H. (Office of Saline Water, Washington, D. C.); Spiewak, I. (Oak Ridge National Lab., Tenn.). Sep 1971. 17p. (CONF-710901–35). Dep. NTIS.

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Operational experience with plants for seawater desalination is reviewed, and various studies for the feasibility and ecomonics of large-scale desalting plants are described. Research and development programs conducted to determine the most economical desalting methods are discussed. Problems in the coupling of power and desalting plants are examined. 20 references. (H.D.R.)

39326 (JUL-704-RG) POSSIBILITY OF ETHYLENE PRODUCTION BY NUCLEAR HEAT. Kugeler, K.; Kugeler, M.; Niessen, H. F. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Oct 1970. 20p. (In German). Dep. NTIS (U. S. Sales Only).

Discussed are the long-term advantages of heat produced by nuclear power plants in comparison to heat produced by fossil fuels. In the future increasing importance can be expected for the pro-

duction of ethylene from crude oil cracking. Following a brief description of the existing technology, a proposal is analyzed in detail which projects the coupling of reactor heat with the cracking process. Problems associated with this technique are discussed. Special consideration is given to the safety of such a nuclear facility. 8 references. (tr-auth)

Marine and Portable Power Reactors

39327 SAFETY CONSIDERATIONS FOR NUCLEAR POWER PLANTS ON MERCHANT SHIPS. Technical and Research Bulletin No. 3-18 1965. New York; Society of Naval Architects and Marine Engineers (1965). 35p. Available from Society of Naval Architects and Marine Engineers, New York.

Guides for the design, construction, and operation of surface merchant ships containing nuclear power plants are presented. The guides cover containment, shielding, waste disposal, reactor loading and startup, controls and instrumentation, standby and emergency components, personnel, inspection and maintenance, and operating restrictions. (H.D.R.)

Reactor Theory

39328 (CEA-N-1416) EFFECT OF FISSILE NUCLEI CONSUMPTION ON POWER AND TEMPERATURE DISTRIBUTIONS IN A FUEL ELEMENT. Citerici, Roger; Cusset, Jean; Di-Falco, Christian (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Feb 1971. 57p. (In French). Dep. NTIS (U. S. Sales Only).

The evolution of the fissile nuclei number and the temperature distribution inside a fuel element subjected to a long irradiation were studied. The use of hybrid computer enabled the algebraic and differential equations system to be solved. After a short report on the calculation method used, the task assigned to analog, logic, and digital components of the hybrid computer is explained. (auth) (France)

39329 ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF THE VIBRATION OF CYLINDRICAL REACTOR FUEL ELEMENTS IN TWO-PHASE PARALLEL FLOW. Gorman, D. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng.; 44: No. 3, 277-90(Jun 1971).

It is generally agreed that lateral vibration of reactor fuel elements is random in nature and is caused by random pressure fluctuations acting on the element surface. A series of tests was conducted in which a single test element was subjected to two-phase parallel flow in a circular annulus. Statistical properties of the amplitude of vibration were measured for various simulated steam qualities with fixed mass flow rate. Statistical properties of the two-dimensional pressure field surrounding the element were also taken. These properties were used in conjunction with the linear random vibration theory to arrive at predicted values for vibration amplitude. Good agreement was found between measured and predicted values of vibration amplitude. It is shown that a high peripheral correlation of the driving forces is primarily responsible for the larger vibrations encountered in two-phase flow. Spectral analysis of the driving forces is provided with a view toward providing useful information for fuel design. 16 references. (auth)

39330 BOUNDED ESTIMATORS FOR FLUX AT A POINT IN MONTE CARLO. Steinberg, Herbert A. (Mathematical Applications Group, Inc., White Plains, N. Y.); Kalos, Malvin H. Nucl. Sci. Eng.; 44: No. 3, 406-12(Jun 1971).
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Methods are given for obtaining bounded estimators for radiation flux at a point detector in a Monte Carlo calculation. In essence, the procedure is to so bias the collision density in the neighborhood of the detector that the usually singular last-flight estimator gives bounded results. The change with respect to usual Monte Carlo procedures is "local" in that only collisions within a fixed neighborhood of the detector are affected. A reselection procedure is used to implement the local requirement. (auth)

39331 $SP_N - P_L$ METHOD FOR NEUTRON TRANSPORT IN HOMOGENEOUS SLABS WITH ANISOTROPIC SCATTERING. Kschwendt, H. (Centre de Calcul, Kirchberg, Luxemburg). Nucl. Sci. Eng.; 44: No. 3, 423-34(Jun 1971).

A synthesis and generalization of several recently developed methods for the numerical solution of the neutron transport equation in a homogeneous slab, assuming anisotropic scattering and energy dependence is presented. The generalization lies in the explicit inclusion of anisotropic scattering. After a Fourier transformation, a system of linear integral equations is obtained, the kernel of which is expanded in spherical Bessel functions. To process the final result in the direction of numerical evaluation, an approximation is proposed that results in the direction of numerical evaluation, an approximation is proposed that results in the $SP_N - P_L$ method where the flux is given by a double sum over spatial and angular Legendre polynomials. The expansion coefficients are determined from a system of linear integral equations. Treating the energy dependence by means of the multigroup concept, this system is reduced to a linear system of algebraic equations. Corresponding matrix elements depend on the optical thickness of the slab and can be computed from expansions available for arbitrary slab thicknesses. The $SP_N - P_L$ method is of great practical importance since it is possible to obtain the solution of the transport equation with low computational effort. For example, assuming monoenergetic neutrons and isotropic scattering, the first and second eigenvalues of the transport equation can both be obtained with five exact digits from 3×3 or 4×4 matrices. The influence of the mean value of the linear anisotropy on the first and second eigenvalue and the decay constant is studied in detail. The validity of the approach is confirmed by comparing it with the S_N and other methods. For certain mean values and optical thicknesses the second eigenvalue is found to be a complex number. Critical flux distribution is determined with great accuracy and shows perfect agreement with other published values. The flux due to a δ source, and a combination of a δ source with a flat one, is analyzed; it is confirmed that the $SP_N - P_L$ method is not only applicable to small systems, but also (in most cases) to very large assemblies. (32 references) (auth)

Kinetics

39332 (AAEC/E-213) PEARLS: A CODE FOR THE SOLUTION OF THE NEUTRON SLOWING DOWN EQUATIONS IN MULTI-REGION LATTICES OF RESONANCE ABSORBERS. Chiarella, C. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1971. 25p. Dep. NTIS (U. S. Sales Only).

The code PEARLS calculates the resonance escape probability by numerically solving the neutron slowing down equations. The code uses collision probability methods for the spatial aspects of the multiregion problem (up to 4 regions) and uses resonance data covering the range 20 keV to 0.07 eV with 124,000 energy points. The program is written in FORTRAN for the IBM 360/50H computer. Most calculations are carried out in double precision (64 bits) although the main bulk of information is stored in single precision (32 bits). (auth)

39333 REACTOR-NOISE ANALYSIS. Seifritz, W.; Stegemann, D. (Technische Univ., Hanover). At. Energy Rev.; 9: No. 1, 129-76(Apr 1971).

A complete survey of the present status of noise analysis techniques is presented. The review is divided into three main sections: a survey of the historical development of zero-power reactor-noise theories deals with different theoretical models: noise analysis in zero-power reactors including experimental methods and results covers different techniques in the time domain as well as in the frequency domain: and noise analysis in reactors at power describes present simple theoretical models with and without feedback. A review is also given on the more sophisticated power-noise models as well as experimental results. (auth)

39334 COMPUTERS AND THEIR ROLE IN THE PHYSICAL SCIENCES. Fernbach, S.; Taub, A. New York; Gordon and Breach, Science Publishers, Inc. (1970). 635p.

The use of digital computers for research programs in chemistry and physics and for reactor design calculations is described. The development of digital computer systems is reviewed. Separate abstracts are presented for 5 of the 24 chapters included. (D.C.C.)

For abstracts of individual chapters see: 37646, 37647, 38444, 39102, and 39335.

39335 COMPUTERS AND REACTOR DESIGN. Bareiss, E. H. (Argonne National Lab., Ill.). pp 337-84 of Computers and Their Role in the Physical Sciences. /Fernbach, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1970).

The use of digital computers for developing and designing nuclear reactors is described. Basic reactor physics calculations are discussed. Computer capabilities and cost analyses for reactor design calculations are compared. 52 references. (D.C.C.)

XUM

39336 OPTIMAL CONTROL OF STEADY STATE NEUTRON FLUX DISTRIBUTION IN SLAB REACTORS. Koga, Ryuji; Hattori, Yoshio; Iwazumi, Tetsuo (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 5, 267-76(May 1971).

The algorithm is presented for seeking optimal control of the steady state neutron flux distribution making use of Pontryagin's Maximum Principle, for a one group model of the bare slab reactor as well as for a two group model of the reflected slab reactor, both ot which are homogeneous except for the control material. The performance criterion to be minimized is the spatial square integral error between the thermal flux distribution and the desired flux shape, and the control variable is the cross section of the absorbing material. A numerical example is given for the bare reactor where the desired shape is assumed to be uniformly flat. The non-linear nature of the problem imparts a complex aspect to the algorithm concerning the steepest descent method, as indicated by the numerical example. The results show that, as the bounds of the control variable are relaxed, the number of switchings is increased and a better performance criterion is obtained but this is accompanied by a higher hot spot factor. 9 references. (auth)

39337 COMMENTS ON CERTAIN INSTABILITIES IN THE INITIAL-VALUE PROBLEM. Protopopescu, V. (Inst. for Atomic Physics, Bucharest). Nucl. Sci. Eng.; 44: 116-17(Apr 1971).

Kuscer (NSA 22: 30370) has shown that predicting the time evolution of an initial pulse in a moderator is a question that can be transferred to studying certain features of the Laplace transform technique. It is shown here that lack of an analytic form for the true scattering kernel renders solution for the neutron distribution unpredictable. A soluble model such as that of Corngold (NSA 18: 21142), however, is stable against small changes of the kernel due ultimately to experimental uncertainties in measuring the cross sections. (R.W.R.)

39338 ANALYTICAL REACTOR EXCURSION MODEL WITH DELAYED NEUTRONS. Leonard, B. E. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Nucl. Technol.; 11: No. 2, 159-74(Jun 1971).

The Fuchs–Nordheim model is extended to develop an approximate solution for reactor excursion analysis which includes delayed neutrons and nonadiabatic systems. The division of the time domain allows a superposition of the prompt burst power as predicted by the Fuchs–Nordheim solution and the delayed neutron tail power. The solutions are applicable to reactor excursions of $1.00 or above up to the time the physical or nuclear dynamic properties are changed (such as by moderator expulsion or core meltdown) or when space–time effects dominate. Time dependent relations for both reactor power and energy generated are obtained. The initial delayed neutron tail power is shown to be nearly independent of pulse size. Experimental time dependent measurements of TRIGA pulses from $1.00 to $3.21 are reported and compared, peak power and energy generated to peak power are provided. Time dependent excursion data for the HPPR and TREAT reactors are also compared with predictions of this theory. The theoretical results are provided with figures of reactor power and total energy generated for application to excursions with minimum periods from 0.002 to 1.0 seconds for reactor systems with ^{233}U, ^{235}U and ^{239}Pu fuels. (24 references) (auth)

39339 THEOREM CONCERNING REFLECTION AND TRANSMISSION FROM A NONABSORBING SLAB. Aronson, Raphael (New York Univ., N. Y.). Nucl. Sci. Eng.; 44: No. 3, 449-50(Jun 1971).

A relation that occurs when an isotropic flux distribution is incident on a nonabsorbing slab in which the particles can undergo energy independent interactions is examined. It is shown that the sum of the transmitted and reflected angular fluxes in a direction making an angle $\cos^{-1}\mu$ with the outward normal is independent of μ. (auth)

39340 APPROXIMATE TREATMENTS OF THE EFFECT OF ANISOTROPY ON ELASTIC NEUTRON MODERATION. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 44: No. 3, 442-4(Jun 1971).

The effect of anisotropic elastic scattering on the neutron spectrum in fast reactor assemblies is examined. The transport approximation is examined within the framework of continuous slowing down theory and an approximation for correctly predicting the first lethargy moment of the elastic slowing down kernel is suggested. (H.D.R.)

Dynamics

39341 (EURFNR-815) DAS-2: DYNAMIC SIMULATOR WITH DEAD-TIME ELEMENTS FOR DIGITAL COMPUTERS. Koepp, C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-1142. 32p. (EUR-3695). Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The DAS-2 program is a digital computer program to calculate dynamic problems which can be stated by a system of algebraic equations, equations with delay and dead-time elements as well as ordinary differential equations with initial conditions. The DAS-2 program can be used to solve all calculations which can be performed with the analog computer (but not problems since, for instance, no provision has been made for the input of data arriving from the sensor). Moreover, problems can be handled which contain functions which can not be solved by means of the analog computer (e.g., call of the steam table, solution of complicated algebraic equations) but can be solved with the digital computer (the FUNC block has been provided for this purpose). (auth)

39342 DYNAMICS OF NUCLEAR REACTORS. Hetrick, David L. Chicago; University of Chicago Press (1971). 549p. $18.50.

The subject of reactor dynamics is presented under the following main headings: elementary derivation of the dynamics equations; constant reactivity and reactivity steps; time-dependent reactivity; integral equations and numerical computations; reactivity feedback and reactor excursions; linear system stability; nonlinear system stability; and space-dependent neutron dynamics. (D.C.C.)

39343 INFLUENCE OF POWER FLATTENING ON HOT CHANNEL FACTORS. Amendola, A. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng.; 44: No. 3, 435-7(Jun 1971).

The influences of flattening the power and temperature profiles on hot channel factors in uniform cylindrical and slab cores are analyzed. The purpose of the analyses is to investigate the maximum power and the maximum coolant outlet temperature that can be obtained in a core with the restriction that the non-failure probability is constant and equal to a preassigned value. (H.D.R.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 37401, 37594, 37673, 37694, 37918, 37923, 37933, 37993, 38016, and 39142.

39344 (CONF-710512-7) FATIGUE AND FRACTURE RELIABILITY ANALYSIS OF PRESSURE VESSELS. Lomacky, Oles (Naval Ship Research and Development Center, Washington, D. C.); Ang, Alfredo H.-S.; Amin, Mohammad (Illinois Univ., Urbana). 12 Feb 1971. 11p. (71-PVP-47). ASME, New York $2.00.

From first national congress on pressure vessels and piping; San Francisco, Calif. (10 May 1971).

An approach to the safety assessment of pressure hulls is proposed based on a probabilistic model of fatigue and fracture. Essentially, such a mathematical model permits the evaluation of the effect on structural reliability of the statistical variabilities in material properties, initial and critical flaws, and in the applied loading. The mathematical formulation of the general reliability model for crack extension is based on treating the initial crack size, the growth rate, and the applied stress field as random variables. Obtaining first the probability of failure for a single crack as a function of the number of load applications, the reliability for the entire hull is then derived by considering specified zones of the potential crack growth. The required probability information for the implementation of the model is identified. An illustration of the calculational procedure based on a specific crack propagation law is presented and some of the design implications are discussed. (17 references) (auth)

39345 (IAEA-119, 3p.) RELIABILITY OF NUCLEONIC REACTOR CONTROL INSTRUMENT SYSTEMS. Wilson, I. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116-31). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The performance of more recent designs of reactor control instruments is not inconsistent with the failure rate expected from random component failures. The designs involved make use of integrated circuits only to a minor extent so they are essentially discrete component designs. It is arguable whether this class of instrument will ever become predominately of integrated circuit construction. In recent years in the United Kingdom many all-solid-state nucleonic instruments have been

put into service and it can be said that all these goals have been achieved. The improvement in reliability is analyzed. (INIS)

39346 (IAEA–119, 3p.) REDUNDANCY IN REACTOR CONTROL AND SAFETY SYSTEMS. Wilson, I. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–32). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

Implementation of the logic of safety systems has employed electromagnetic relays almost exclusively. The DIMPLE research reactor, however, uses transistors and small toroidal "square loop" ferrite cores throughout almost the entire safety and interlock logic system. Safety system logic in later nuclear generating stations employs logic based on multi-aperture ferrite cores for the voting and guard time circuits and their use is spreading to the interlock circuits also. The development of the underlying philosophy of "redundant" control systems and the techniques of implementing them are considered a useful preliminary to the broader issues of implementing control systems where redundancy in the computer complex, as well as in sensors and actuators, is necessary to achieve a result which is acceptable from the operational and safety viewpoints. (INIS)

39347 (IAEA–119, 7p.) RELIABILITY INVESTIGATIONS OF REACTOR SYSTEMS. Bastl, W. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–5). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

In the Federal Republic of Germany, reliability techniques are investigated and applied to the reactor field. There are a lot of codes of different capacity available for calculating the reliability of more or less complex systems. A program RELIAG is widely applied. This program is described briefly. (INIS)

39348 (IAEA–119, 47p.) PRELIMINARY REPORT ON PREDICTING THE RELIABILITY OF "TWO-OUT-OF-THREE" LOGIC SYSTEMS WITH SELF-CHECKING AND REPAIR. Zobor, E. (International Atomic Energy Agency, Vienna (Austria)). 1970. (CONF-691116–34). NTIS (U. S. Sales Only).

From IAEA panel study on instrumentation for control of nuclear power stations; Vienna, Austria (17 Nov 1969).

The application of semiconductor logic elements in reactor safety systems gives the possibility of further improving the reliability of reactor protection by automatically testing the workability of the logics. By the application of self-checking safety systems the "unsafe failures", i.e. the failures which remain hidden, will be detected and the repair can take place according to certain strategies, predetermined on the basis of safety considerations. The reliability of the "two-out-of-three" fundamental logic system, coupled with a checking system, is investigated as a finite-state Markovian process where the state transitions occur in the consequence of failures, detection and repair. Dependent upon the minimum operational requirements under which the reactor can be kept operating and from the safety philosophy adopted for the repair strategy, certain sets of system states will be accepted as successful ones and certain transitions will be prohibited. (auth) (INIS)

39349 (LA–4676) TWODIM: A COMPUTER CODE FOR UNFOLDING DIAMETRAL GAMMA-RAY SCANS ON REACTOR FUEL ELEMENTS. Barnes, B. K.; Phillips, J. R. (Los Alamos Scientific Lab., N. Mex.). May 1971. Contract W-7405-eng-36. 28p. Dep. NTIS.

A computer code was written to accept one or more diametral scans taken at different angles around the outside of a fuel element and use this information to determine the distribution of the measured isotope over a cross section of the fuel element. The calculated distribution is plotted both as an isometric projection plot and as a density plot. Fission-product distributions calculated with this code were compared to actual distributions measured on thin cross sections of the fuel. (auth)

39350 NUCLEAR ENERGY AND THE FOSSIL FUELS. Folinsbee, R. E. (Univ. of Alberta, Edmonton). Trans. Roy. Soc. Can.; 7: 335-59(1970).

Nuclear energy, fission or fusion, will take over from fossil fuels as our major source of energy within a few decades. A survey is made of the oil and coal sources in the world with particular reference to Canada. Twenty-six maps and graphs are used to illustrate. In longer-term prospective it is clear that Canada will make only a small splash in the world's petroleum pool. Energy for the future must be nuclear and cars electrical. (F.S.A.)

39351 ENGINEERING IMPLICATIONS OF NEUTRON-IRRADIATION EMBRITTLEMENT OF REACTOR PRESSURE VESSELS. Nichols, R. W.; Cowan, A. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). At. Energy Rev.; 9: No. 1, 3-127(Apr 1971).

The implications of neutron radiation embrittlement on the operation of reactor pressure vessels are discussed. A review is made of the approaches which have been applied to assess the risk of fast fracture in steel structures and the interpretations which have been placed on test data are discussed. After summarizing the effects of irradiation and the methods of measurement of irradiation embrittlement, the use of surveillance programs in reactor pressure vessels and the application of data from them is described in detail. The principles of existing and projected programs and philosophies to guard against fast fracture are discussed and the areas in which further studies should be made are highlighted. (auth)

39352 PRESTRESSED CONCRETE VESSEL FOR A NUCLEAR REACTOR. Arathoon, Jean-Paul; Gigou, Roger (to Societe pour l'Industrie Atomique (Socia)). British Patent 1,235,280. 9 Jun 1971. Priority date 13 May 1969, France.

PRESSURE VESSELS—design parameters of cylinder shaped prestressed concrete

REACTORS—pressure vessels for, design parameters of cylinder shaped prestressed concrete (D.C.C.)

39353 CONTROL SYSTEM FOR GAS-FILLED CONTROL ROD. Roche, Roland (to Commissariat a l'Energie Atomique). British Patent 1,234,829. 9 Jun 1971. Priority date 13 Nov 1967, France.

REACTOR CONTROL ELEMENTS—gas flow regulating system for gas filled (D.C.C.)

39354 SPACING DEVICE FOR THE FUEL PINS OF A NUCLEAR REACTOR. Feutrel, Claude (to Commissariat a l'-Energie Atomique). French Patent 2,034,419. 11 Dec 1970. Filed 28 Mar 1969. (In French).

The spacing device for the clad fuel pins of a nuclear reactor consists of a hollow tube of circular cross section. It is wound in a spiral about the pin and closed at both ends which are welded to the plugs closing the fuel pin can. (France)

39355 PRESSURE TUBE REACTOR. Foulquier, Henri; Thome, Paul (to Commissariat a l'Energie Atomique). French Patent 2,034,266. 11 Dec 1970. Filed 5 Mar 1969. (In French).

A tube assembly for a nuclear reactor is presented. Each pressure tube defines, with its outer coaxial calandria tube, all along the core passage, an annular space filled with a fluid. The pressure of the fluid is intermediate between the pressure of the coolant inside the pressure tube and the pressure of the moderator around the calandria tube. The annular space is closed from one side of the core to the other by a rigid connection between the pressure tube and calandria tube and by a deformable system which enables the differential expansion of these tubes. The risk of creep in the pressure tubes is suppressed without any enhancement of the neutron absorption in the inner structures of the reactor core. Expansion bellows enable the control, the monitoring, and the disassembly of the elastic system to be performed without interfering with the reactor core. (France)

39356 DEVICE LINKING FUEL PINS. Feutrel, Claude (to Commissariat a l'Energie Atomique). French Patent 2,036,902. 31 Dec 1970. Filed 16 Apr 1969. (In French).

At the end of the operation of a cluster type fuel element it is necessary to disassemble the pins. Such a procedure is delicate and complicated. A device is described which links these pins without involving serious mechanical stresses, and allows their differential longitudinal expansions and certain independent torsions. The device involves only a negligible load on the path of the refrigerant circulating in each cluster of pins. (auth) (France)

39357 SAFETY DEVICE FOR A NUCLEAR REACTOR. Aubert, Gilles; Vrillon, Bernard (to Commissariat a l'Energie Atomique). French Patent 2,038,062. 8 Jan 1971. Filed 19 Mar 1969. (In French).

A liquid poison safety device is described. The device utilizes a tube in the form of a finger of a glove fixed at its lower end to a reservoir of liquid poison. A pipe is included for leading in and evacuating the neutral, almost nonabsorbing gas filling this tube which axially transverses the reservoir and opens at one end into the upper part of the glove finger at the level of the bottom of the reservoir and at the other end into the reservoir above the liquid. A system is provided for retaining the liquid in the reservoir and controlling its release into the tube. A draining channel joins the lower part of the glove finger to the upper part of the liquid reservoir. The device assembly is mounted inside a vertical canal in the core of the reactor. (auth) (France)

XUM

39358 DETERMINATION OF PYROCARBON THERMAL CONDUCTIVITY BY THE BURST-REACTOR TECHNIQUE. Salgado, Peter G. (Los Alamos Scientific Lab., N. Mex.); Schilling, Fred P.; Brock, Gerald T.; Holman, Kermit L. Nucl. Technol.; 11: No. 1, 131-43(May 1971).

A novel technique for measuring in situ the thermal conductivity of the pyrocarbon coatings of coated particle fuel is presented. Spherical nuclear fuel particles were overcoated with W, and chromelconstantan thermocouple wires were welded tangent to the W layer and 180° apart. These intrinsic thermocouples or fission couples were subjected to neutron bursts and the surface temperature responses monitored. From knowledge of particle dimensions, burst shape, and estimates of density and heat capacity, the effective thermal conductivity of the pyrocarbon coats was calculated using a finite difference approximation to the energy equation. Experiments were conducted to measure the thermal conductivity of a low density pyrocarbon buffer coat and comparisons were made between values obtained by the fission couple method and the Xe-flash method for two dense pyrocarbon coatings. A TRISO I particle was tested and the thermal conductivity of the buffer layer was estimated to be 0.0039 ± 0.0011 cal $cm^{-1}sec^{-1}{}^{o}C^{-1}$. (17 references) (auth)

GENERAL

39359 (ACRH–35) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION. Gottschalk, Alexander (ed.) (Argonne Cancer Research Hospital, Chicago, Ill.). Mar 1971. Contract AT(11-1)-69. 119p. Dep. NTIS.

39360 (ACRH–1000-247) PANCREAS SCANNING: IS IT WORTH IT? Landman, Silviu; Polcyn, Robert E.; Gottschalk, Alexander (Argonne Cancer Research Hospital, Chicago, Ill.). [1970]. 13p. (CONF-701129-1). Dep. NTIS.
From fifty-sixth annual meeting of the radiological society of America; Chicago, Ill. (29 Nov 1970).

39361 (ANL-ES-5) PHENOMENOLOGICAL RELATIONSHIP FOR PREDICTING THE SURFACE AREAS OF THERMAL PLUMES IN LAKES. Asbury, J. G.; Frigo, A. A. (Argonne National Lab., Ill.). Apr 1971. Contract W-31-109-eng-38. 20p. Dep. NTIS.

39362 (BDX-613-291) INVESTMENT CASTING TO ENHANCE PRODUCIBILITY: A CASE STUDY. Cromwell, W. E. (Bendix Corp., Kansas City, Mo.). Mar 1971. Contract AT(29-1)-613. 47p. Dep. NTIS.

39363 (BNWL-SA-3716) ANALYSIS OF CRUSTAL CHANGES IN THE COLUMBIA PLATEAU AREA FROM CONTEMPORARY LEVELING AND TRIANGULATION MEASUREMENTS. Tillson, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan 1971. Contract AT(45-1)-1830. 12p. (CONF-710424-1). Dep. NTIS.
From Northwest scientific association annual meeting; Moscow, Idaho (16 Apr 1971).

39364 (COO–894-7) ENERGY TRANSFER AND UTILIZATION IN BIOLOGICAL SYSTEMS. Progress Report, April 16, 1970–April 15, 1971. Lumry, Rufus (Minnesota Univ., Minneapolis. Dept. of Chemistry). Contract AT(11-1)-894. 7p. Dep. NTIS.

39365 (COO–910-26) VIROLOGIC AND IMMUNOLOGIC STUDIES OF C-TYPE VIRUS PARTICLES ISOLATED FROM BOVINE LEUKEMIA. Dutta, S. K.; Larson, V. L.; Sorensen, D. K.; Perman, V.; Hammer, R. F. (Minnesota Univ., St. Paul. Coll. of Veterinary Medicine). [1971]. Contract AT(11-1)-910. 31p. Dep. NTIS.

39366 (COO–1599-38) DISSOLVED ORGANIC MATTER AND LAKE METABOLISM. Technical Progress Report, April 15, 1970–May 1, 1971. Wetzel, Robert G. (Michigan State Univ., Hickory Corners. W. K. Kellogg Biological Station). 30 Apr 1971. Contract AT(11-1)-1599. 38p. Dep. NTIS.

39367 (COO–1632-29) MECHANISMS OF IMMUNOSUPPRESSION AND CELLULAR MECHANISMS OF SECONDARY DISEASE. Technical Progress Report, September 1, 1970–August 31, 1971. Uyeki, Edwin M. (Kansas Univ., Kansas City. Medical Center). 28 May 1971. Contract AT(11-1)-1632. 15p. Dep. NTIS.

39368 (COO–1721-46) ELECTRON MICROSCOPE STUDIES. Technical Progress Report, April 1970–May 1971. Crewe, Albert V. (Chicago Univ., Ill. Enrico Fermi Inst.). Contract AT(11-1)-1721. 13p. Dep. NTIS.

39369 (COO–1820-3) ECOLOGICAL STUDIES ON THE DYNAMICS OF PLANKTONIC BLUEGREEN ALGAE WITH SPECIAL REFERENCE TO THEIR MICROSTRATIFICATION. Progress Report, 1970–1971. Brook, Alan J. (Minnesota Univ., Minneapolis. Dept. of Ecology and Behavioral Biology). Contract AT(11-1)-1820. 8p. Dep. NTIS.

39370 (COO–2118-3) SHOW-AND-TELL: AN INTERACTIVE PROGRAMMING SYSTEM FOR IMAGE PROCESSING. SYSTEM SPECIFICATIONS. Report No. 429. Read, John (Illinois Univ., Urbana. Dept. of Computer Science). 18 Feb 1971. Contract AT(11-1)-2118. 56p. Dep. NTIS.

39371 (COO–2118-8) INTERVAL GENERALIZATION OF SWITCHING THEORY. Report No. 442. Michalski, R. S.; McCormick, B. H. (Illinois Univ., Urbana. Dept. of Computer Science). 3 May 1971. Contract AT(11-1)-2118. 18p. Dep. NTIS.

39372 (COO–2122-6) THE IRON DOG IN ESKIMO CULTURE. Hanson, W. C. ([Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology]). [1970]. Contract AT(11-1)-2122). 20p. Dep. NTIS.

39373 (DP–1255) GRAVITY FLOW OF A STRATIFIED FLUID TO A SINK. Croach, J. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar 1971. Contract AT(07-2)-1. 76p. Dep. NTIS.

39374 (IS-T–433) KNIGHT SHIFT AND SPIN-LATTICE RELAXATION MEASUREMENTS IN THE PHOSPHIDES WITH THE Ti_3P STRUCTURE TYPE AND IN THE VS_{1+x} SYSTEM. Strachan, Denis Michael (Ames Lab., Iowa). Jun 1971. Contract W-7405-eng-82. 57p. Dep. NTIS.
Thesis.

39375 (IS-T–442) SPECTROSCOPIC TEMPERATURE MEASUREMENTS OF FLAMES AND THEIR PHYSICAL SIGNIFICANCE. Reif, Isaac (Ames Lab., Iowa). Jun 1971. Contract W-7405-eng-82. 86p. Dep. NTIS.
Thesis.

39376 (IS-T–445) TORQUE–KNUDSEN MEASUREMENT OF THE VAPOR PRESSURE OF THE PLATINUM DIHALIDES. O'Brien, William George (Ames Lab., Iowa). Jun 1971. Contract W-7405-eng-82. 76p. Dep. NTIS.
Thesis.

39377 (IS-T–450) HYDROGENATION OF ETHYLENE ON IRIDIUM THIN FILMS. Masterson, Paul Bruce (Ames Lab., Iowa). Jun 1971. Contract W-7405-eng-82. 159p. Dep. NTIS.
Thesis.

39378 (IS-T–453) NUCLEOPHILIC ATTACK ON COORDINATED ISOCYANIDE AND CARBON MONOXIDE IN CATIONIC IRON COMPLEXES. Charley, Linda Sue McDowell (Ames Lab., Iowa). Jun 1971. Contract W-7405-eng-82. 34p. Dep. NTIS.
Thesis.

39379 (K–1798(Pt.2)) INTERNAL RAREFIED GAS FLOWS WITH BACKSCATTERING. PART 2. FREE MOLECULE FLOW THROUGH FINITE CAPILLARIES. Berman, A. S. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 16 Jun 1971. Contract W-7405-eng-26. 15p. Dep. NTIS.

39380 (K–1798(Pt.3)) INTERNAL RAREFIED GAS FLOWS WITH BACKSCATTERING. PART 3. KRAMER'S PROBLEM: THE EFFECT OF BACKSCATTERING ON SLIP. Berman, A. S. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 16 Jun 1971. Contract W-7405-eng-26. 7p. Dep. NTIS.

39381 (LA-tr–71-45) HYDROSTATIC PRESSURE APPARATUS FOR ELECTRICAL MEASUREMENTS UP TO 17 KILOBARS AT VERY LOW TEMPERATURE. Delplanque, G.; Malfait, G.; Rieux, M.; Jerome, D. Translated for Los Alamos Scientific Lab., N. Mex., from Rev. Phys. Appl.; 5: 731-6(1970). 16p. Dep. NTIS.

39382 (NYO–3549-64) BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURTSEY AND ENVIRONMENT FOR THE YEAR 1970. Technical Progress Report. Fridriksson, Sturla (Surtsey Research Society, Reykjavik (Iceland)). Contract AT-(30-1)-3549. 65p. Dep. NTIS.

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Germanic	ä	appears as ae
Germanic	ö	oe
Germanic	ü	ue
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SUBJECT INDEX

Cross references are included in cumulative subject indexes and in *Subject Headings Used by the USAEC Division of Technical Information* (USAEC report TID-5001).

The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are specific materials, things, and processes. The headings are followed by modifiers that describe the properties of, or processes applied to, the headings.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE. In general, the nomenclature used is that of the subject indexes to *Chemical Abstracts*.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MANGANESE FLUORIDES
MANGANESE FLUORIDES MnF_2
MESONS
MESONS (π)
MESONS (ρ)
1-PENTANOL
2-PENTANOL

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—sorption by charcoal should be read "hydrogen sorption by charcoal." As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—yields in radiolysis of ethyl ether, effects of deuterium on, should be read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and URANIUM—crystal structure of, effect of cooling rate on allotropic transformations in, should be read "effect of cooling rate on allotropic transformations in crystal structure of uranium."

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically, e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Organic compounds are indexed by subject headings based on the indexes to *Chemical Abstracts* except in the area of enzymes, in which specific enzymes, named according to the 1964 recommendations of the International Union of Biochemistry, are used. In many cases nonproprietary names for drugs are used as subject headings, and cross references are made from the systematic chemical names. Subject headings for hormones appear in the inverted style at HORMONES.

Nomenclature of Life Sciences

Subject headings for plants are names of phyla with one exception: members of the Phylum Tracheophyta are indexed under class or subclass names. Scientific names (genus and species) are used as the initial, or file, word in the modifying phrase. Scientific names are omitted only when the name is not available in the literature or cannot be found in available references.

Subject headings for animals are the names of phyla with the following exceptions: (1) members of Phylum Arthropoda and Phylum Chordata are indexed under appropriate class name, and (2) common names are used for members of Class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are DISEASES; DISEASES, INFECTIOUS; DISEASES, NEOPLASTIC; DISEASES, PHYSIOLOGICAL; DISEASES, PLANT; and DISEASES, TRAUMATIC.

Diseases of mixed etiology are treated in the following manner: neoplastic diseases that are also classified as infectious or physiological are indexed under DISEASES, NEOPLASTIC; diseases in which a microorganism is the etiologic agent are classified under DISEASES, INFECTIOUS; physiological anomalies that are neither neoplastic nor infectious are indexed under DISEASES, PHYSIOLOGICAL; the acute radiation syndrome, nonspecific radiation injuries, trauma, and wounds or incisions inflicted mechanically are indexed under DISEASES, TRAUMATIC.

Specific diseases or pathological conditions are named in the file-word position of the modifier, in the author's terminology, and are set off from the remainder of the modifier by commas. Neoplasms are designated as benign or malignant in the file-word position when more specific information is not available.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V,...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

```
LEAD TITANATES
  PbTiO3--PbZrO3
LEAD ZIRCONATES
  PbTiO3--PbZrO3
```

XUM

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

ALUMINUM OXIDES
  Al_2O_3--Cu, ...
COPPER ALLOYS AND SYSTEMS
  Al_2O_3--Cu, ...

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

ACETIC ACID
  acetic acid--BF_3, ...
BORON FLUORIDES
  acetic acid--BF_3, ...

Example:

BENZENE, CHLORO-
  bromophenol--chlorobenzene, ...
PHENOL, BROMO-
  bromophenol--chlorobenzene, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

CARBON SYSTEMS
  deposition on nuclear fuel particles
  molecular structure of
  neutron total cross section for
  sorptive properties for xenon
  Young's modulus for
  Al--C--Cr, superconductivity in
  B--C, phase studies for
  C--U--Zr, fabrication and physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of Rosenfeld, et al. *Data on Particles and Resonant States*, UCRL-8030 (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: Λ-He^5, Σ-H^3, $\Lambda\Lambda$-Be^{10}. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

MESONS (π^-)
  interactions $\pi^- + p \rightarrow \Lambda + K^+ + \pi^-$ at 6 GeV/c in hydrogen bubble chamber, $\Lambda K(1700)$ enhancement in, (E)
BARYONS, RESONANCE (N*)
  production of $\Delta^{++}(1236)$ and $\Delta^0(1236)$ from $K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and 2.70 GeV/c, (E)
HYPERFRAGMENTS
  binding energy of $\Lambda\Lambda$-He^6, three-body o--Λ--Λ model for

Subject headings are also provided for specific models and theories.

Examples:

ELEMENTARY PARTICLE MODELS (TRIPLET)
  hadron total cross sections in quark, numerical analysis of
CURRENT ALGEBRA
  PCAC hypothesis for A_1 and rho dominance in $\pi \rightarrow e + \nu + \gamma$ decay
REGGE POLE THEORY
  predictions for polarization in $K^- + p \rightarrow$ anti $K^0 + n$, $\pi^- + p \rightarrow \pi^0 + n$, and $\pi^- + p \rightarrow$ eta + n interactions at high energies
SYMMETRY GROUPS
  SU(2) × SU(4) intermediate-coupling model for nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (1) or (2) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

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Reports, conference papers and proceedings, numbered translations, and patents are included in this index. Each item is listed by report number; this is followed by the abstract number and a brief notation regarding public availability. The index entries show which reports are on file in the institutions listed on the back of the front cover (Dep.), which reports have been published in open-literature journals (journal citation), and which reports can be purchased (source and price). Whenever a report is identified by more than one number, the availability is given under the primary number, and a cross reference is given under the secondary report number.

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Service Central de Protection contre les Rayonnements Ionisants. Copies are available from Ministère de la Santé Publique, Service Central de Protection contre les Rayonnements Ionisants, B.P. n° 78 Le Vesinet (France) Telex 25667.

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If published proceedings are received after the receipt of individual papers, the complete proceedings will be abstracted and the abstract number will appear in this index with the base CONF number.

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